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Naval Personnel and Training Research Lab.

Job Training course design and improvement.

26 June 1970

Final Review Draft

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FINAL REVIEW DRAFT

JOB TRAINING COURSE DESIGN AND IMPROVEMENT
(Second Edition)

by

Edward A. Rundquist

NAVY TRAINING RESEARCH LABORATORY

in cooperation with

COMMANDER TRAINING COMMAND
U. S. PACIFIC FLEET

PF39.522.004.01.02
Research Report SRR ____ N. F.

Submitted by

Edward A. Rundquist, Ph.D., Director
Motivation and Individual Differences Research Department

Approved by

E. I. Jones, Ph.D., Director, Navy Training Research Laboratory
E. E. Dudek, Ph.D., Technical Director
Karl E. Kuehner, Commander, USN
Commanding Officer

Naval Personnel and Training Research Laboratory
San Diego, California 92152

A LABORATORY OF THE BUREAU OF NAVAL PERSONNEL

TABLE OF CONTENTS

FORWARD

The factual discoveries and insights gained from research on the course design process made this revision of the Manual necessary. This edition is virtually a complete rewrite. It supercedes early editions and can be read without reference to them. Major changes from earlier editions will be found in:

a. More careful definitions of the training and training related terms used.

b. A general clarification of concepts and procedures, especially those concerned with job analysis and skill analysis for training purposes, with principles of developing training exercises and curriculum outlines.

c. More emphasis on the significance of the course mission for course design.

d. A more thorough consideration of the importance and means of adapting to individual differences.

e. Examples from a wider variety of duty assignments.

We have been encouraged in the revision effort by the apparent need for a document of this kind reflected in the unexpected spread of its use beyond the Training Command, Pacific Fleet (COMTRAPAC), its original sponsor. The demand for copies has exhausted three reprintings and has come from a wide variety of installations in and out of the Navy, COMTRALANT, Naval Submarine Base, New London; individual Pers-C schools in the major Service School Commands are examples of requestors within the Navy.

The Manual does not contain most of what is known about such things as instructional techniques and media, evaluation, simulation, adult

learning; hence, it needs supplementing for many specifics. It does provide a way of proceeding in course design and redesign. It emphasizes what are considered the really significant principles, and the procedures for carrying out the steps, especially the more difficult ones. It stresses the need for identification of the job tasks for which the training is given and the restriction of course content, especially information and theory, to the minimum needed to learn to perform the job task The correct context to learn both mental and physical skills is that part of the job which requires their use. The most forceful arguments for not teaching more than needed are: (1) one of the best established principles in all psychology is the rapid rate of forgetting. What is not soon used is soon forgotten, and (2) there is so much that is relevant to be learned, there simply is no time for the irrelevant or the nice to know. One can only guess what the dollar savings would be if all such irrelevant material were eliminated throughout the Services, and students were trained for the job assignment to immediately follow.

Courses that are taught in general terms, e.g., leadership, management, introductory, inevitably suffer from the lack of a context in which what is taught is to be used. All too often the instruction is conducted as though job task requirements had no influence. The design of such courses could be improved markedly by a specification of the job tasks, e.g., of a particular leadership assignment. Some of the job tasks will differ in leadership of a shore patrol, a combat patrol, a

planning mission, and a managerial assignment. And these differences must be reflected in the objectives of a leadership training course, if it is to be really effective. General training is for the staff specialist, not for line personnel who have jobs to do for the organization.

The minimum that should be done for introductory courses is to devise performance tasks which represent the application of theory or use of information most likely required on the first job assignment. A good example of devising a vehicle for introductory electronic instruction is found in Pickering and Anderson (1966). A superhetrodyne receiver was developed. Job and training tasks concerning functions, cirucitry, and basic electronic concepts were expressed in terms of the receiver. All concepts were learned in terms of the kind of tasks the student would be performing on the job. Examples of training tasks, using this receiver, are:

> "Given a superheterodyne receiver and a block diagram the student will be able to relate the stage represented by a block in the diagram to the actual stage on the receiver chassis. He will do this by reading the tube number (V-1, V-2, etc.) on the block selected and locating the tube number on the receiver chassis that corresponds to it. He will confirm his comparison by reading the tube type number (6SK7, 6SK8, etc.) in the block and comparing it with the number on the outside of the tube."
>
> "Given a superheterodyne receiver block diagram, the student will be able to give the signal function of each block. He will be able to identify the waveform associated with each block. His response will be judged correct when his reply is: . changes AC to DC, amplifies the IF frequency, etc., and he identifies the waveforms as RF, modulated RF, Audio, etc."

This Manual is concerned only with course design for the job tasks required in support and operational duty assignments. As the Army points out (CON Reg 350-100-1, 1 February 1968):

> "Any attitudes that are essential to job performance must be identified. These attitudes will become a part of the training objectives to insure that they become a part of the training program. For example, one of the greatest hazards associated with ammunition is fire; a positive attitude toward fire prevention is an indispensable attitude for all tasks associated with ammunition."

Such attitudes are not considered herein. Job-expert instructors should keep in mind, however, that the development of attitudes requires more than talking about them. It requires arranging situations so that desired attitudes can be evoked until they are automatically applied.

Designing a training course involves facts and principles from many disciplines, i.e., it is a complex process. It cannot as yet be reduced to strictly cookbook terms. A Manual describing the process reflects this complexity. After one or more readings to acquire a general understanding of what is involved in the course design process, constant reference should be made to the chapter describing the step one is trying to apply.

Application of the course design procedure requires effort on the part of all concerned, from the instructor to top training management. The need for the effort is plain. It is altogether too easy to document that much training is ineffective. Mathematics not used is taught electronic technicians (Anderson, 1962); physics not used is taught welders and non-destructive testers (Wells & Abrams, 1970a); and detailed ASW and AAW tactics is taught CICWOs (Rundquist, 1966, 1967). The footnote on page

III-5 illustrates the point at the officer level. It is not only that much of what is taught is not needed but much that should be is not, or if taught is not taught well. Survey after survey of electronic technicians has found much more inadequacy than there should be in the operation of test equipment (Abrams, 1962a, 1962b, 1965; Anderson, 1960, 1962; Branks, 1966; Pickering & Abrams, 1962a, 1962b; Pickering & Anderson, 1960; Stern & Aiken, 1969). Two surveys of sonar technicians, ten years apart (West, Abrams, Winchell, & O'Brien, 1970) shows that this situation has become worse. That electronic equipment operates at all is a tribute to the efforts of the few technicians found in such surveys <u>who are able to do their job</u>. Current retention figures make one dubious about how long these few will be available.

Successful application of the procedure described in this Manual will go a long way toward improving this situation. Typical Navy course designers will need help in the application by providing instructor training in course design, by arranging for technical assistance in carrying out the steps they find difficult, e.g., job analysis of complex duties. In a word, changes in the Navy training system will be required to fully exploit the procedure. Prior to such changes considerable can be accomplished at the local school level. It is hoped this Manual will help local instructor-designers improve the effectiveness and efficiency of their training courses.

ACKNOWLEDGEMENTS

Preparation of a document of this kind involves the cooperation and support of many naval, professional, and secretarial personnel. For their encouragement and support of the effort that has gone into the preparation and use of the successive editions of the Manual, special appreciation is expressed to two Directors of Instruction, Training Command, Pacific Fleet, CDRS A. J. Weil and LCDR J. C. Meetze, whose tenures have overlapped this research program. Much is owed to the officers in charge of the Class "C" Welding School, Service School Command, San Diego, LT B. E. Myers and LCDR J. A. Bishop, and to a succession of training officers and chief instructors at the Fleet Anti-Air Warfare Training Center, San Diego (FAAWTRACENSD), including CDRS R. J. Callahan, E. J. Hopf, C. E. Langton, LCDRS G. D. Tice and H. J. Sommers, Jr., for their willingness to try out new procedures and to implement recommended changes even when this required substantial effort. To my professional colleagues, especially my staff, I owe much. Recognition of their contributions is given throughout the Manual.

Appreciation is expressed to many who reviewed early drafts of this Manual. Two deserve special thanks for the thoroughness of their review and the number and basic nature of their suggestions: Dr. John P. Smith, a colleague, and Mr. Anthony J. Kral, Educational Specialist, FAAWTRACENSD.

Finally, this edition of the Manual would never have seen the light of day if it were not for the patience of Mesdames Elizabeth M. Chanin and Mary M. Asdell in preparing what seemed an endless series of revisions required to bring about at least a modicum of clarity in the presentation of a very complex subject. Their patience and skill in this effort are gratefully acknowledged.

CHAPTER I

INTRODUCTORY OVERVIEW

The purpose of this document is to describe a systematic procedure for the design of training courses. It also has implications for the design of training programs. The procedure is developed in a manner which (1) takes account of principles from the many technical and professional fields contributing to training technology, (2) keeps course design completely job assignment oriented, and (3) puts the emphasis where the good instructor wants it--on his direct dealing with the student to facilitate his learning.

Two of the most important outputs of the course design procedure are the Task Inventory (TI) and the Basic Curriculum Outline (BCO). For the three courses used as the main vehicles for the development of the procedure--the combat information center watch officer (CICWO) course, the electronic maintenance of the AN/SPA-34 repeater course, and the TIG welding course--these documents are given in Appendices A to F. They are not relegated to the appendices because of a need for occasional reference, but for ease in finding. They will be referred to often in the texts as two of the major outputs of the course design procedure and will require frequent consultation and careful study. This Manual will be much easier to follow if the reader refers to these documents often for examples of what is being described in the text.

training

The starting point for the design of a/course is its purpose or mission. In the context of the mission, learning objectives are derived--the action elements from the job tasks, the conditions element from the manner in which practice is given to learn the actions, and the standard element from measures of what the students have learned. The curriculum is organized in terms of the logic of job tasks, the mental and physical skills to be trained and in terms of learning principles. The course is scheduled in terms of providing the flexibility required to adapt to individual differences in student experience and rate of learning as well as in terms of variation in the location of the duty trained. Lesson plans are developed to attain the objectives, primarily in terms of learning and instructional principles. The degree to which students have met the learning objectives is determined. With this known, effort is directed at improving the course.

1. <u>Need for a Systematic Procedure</u>

The need for a systematic procedure stems from the complexity of the course design process. This is easily illustrated by the number and variety of the questions a course designer must answer. Is the course mission compatible with the training system, the job assignment system, the career management system, the operations system? Is the mission stated so that it can be reasonably and consistently interpreted? Where do the learning objectives come from? How does one derive the action element? the conditions element? the standards element? How does one know when he has all the objectives? How are they best stated to serve both course design and communication purposes? How select among desirable objectives to cope with time constraints? How does one

one organize the course for most effective instruction and for achieving the flexibility necessary to adapt to student differences in experience and in rates of learning? What strategies of learning are most appropriate for particular mental and physical skills? How does one make sure that course changes really improve student learning? How far does course design have to go to ensure that typical instructors can carry it out? to a curriculum outline? to a lesson plan outline? Instructor-designers have faced all these questions and more. Their sheer number reinforces the need for a systematic procedure to cope with them.

Answers to these questions come from a wide variety of technical and professional fields: systems analysis, job analysis, psychological testing, motivation, learning and organizational principles, principles of simulation in the development of classroom or computer-based exercises, educational media, training aids, and techniques. It is the number of technical fields in addition to the job expertness required that forces the use of systematic procedure. It becomes indispensable to managing the course design process in such a manner that principles from the many fields involved are brought to bear at the right times. A procedure also keeps one continuously aware of what problems he is dealing with at what stage in the design process, making it easier to manage.

A systematic course design procedure puts the emphasis on designing a course substantially right in the first place. It will be found by those who really follow the procedure that the time taken is fully compensated for by the time saved in course maintenance and in preparation for inspections. Deletions and additions of learning objectives and the associated instructional time

are easily managed without a total course revision. The curriculum outline and the lesson plans that are normal products of the design process are always in a state of readiness for training management inspection. No hurried, concentrated preparation involving changes on paper, but not in the course, is required. Courses are designed to be effective, i.e., to be directed toward the right objectives. Such courses contribute to improved Navy operations. In addition, the efficiencies gained over time can result in enormous dollar savings. While there is much that can be accomplished by good course design procedures, full exploitation of current training technology very likely will require changes in the entire Navy training system.

2. Definitions

This section will define a number of training and training related terms used in this Manual. They are defined in an order which it is hoped will facilitate their comprehension.

SYSTEM. A group of men, men-machine or machine components organized to achieve a definite purpose or mission. The size and scope of what one wishes to consider a system depends on one's purpose in dealing with it. From the viewpoint of the Department of Defense, the Navy, Army, and Air Force can be viewed as systems to be organized to achieve U. S. Defense goals. From the standpoint of an electronic technician, a particular repeater is a system, although a minor component from the Department of Defense perspective. From the standpoint of training management, an integrated training program encompassing all duty assignments is a system. From the standpoint of the instructor of a single course in this program, the system of concern is the one in which the duty assignment for which he is training his students is a part and the ones in which this system is embedded, i.e., related to and/or part of.

JOB. A grouping of job tasks assigned the person in a particular duty assignment. Used synonymously with duty assignment or duty.

DUTY OR DUTY ASSIGNMENT. The assignment given in the course mission may be a billet or any part thereof, a main or collateral duty. In this Manual, either term will be used only in this restricted sense. Examples are: CICWO, SF 4946, Fuel Gas Welder, AAW Evaluator, Sonar Operator, Sonar Detection and Classification. The term is thus relative to the goal of the training.

BEHAVIOR. Any action, mental or physical. Behavioral action and behavioral element are used interchangeably in this Manual.

TASK. A job action or a training action. When the job action is being referred to, the adjective job will be attached, i.e., job task, unless there is no possibility of confusion. When the training action is being discussed, the adjective training will be attached, i.e., training task.

EXERCISE. A synonym for training task.

TASK LEVEL. A duty assignment is job analyzed into a number of Level I job tasks; each Level I job task, into Level II job tasks, each Level II job task, into Level III tasks; and so on until the smallest tasks to be trained are reached. Levels of training tasks parallel job level tasks.

SKILL. (1) The capability of performing an action with a degree of proficiency; or (2) a particular area of proficiency, e.g., welding; or (3) the mental and physical actions basic to the performance of a job task, particularly basic skills of perception, motor coordination, etc. The context will make clear which meaning is intended. As used in this Manual skill in the third meaning contrasts with job actions. Job actions are the application of the skill, e.g., repairs in metal pipes are made by the welding skill; estimating a CPA is done by applying the skill of solving problems of relative motion; evaluating a tactical situation is done by the menta

skill of integrating appropriate information; determining course and speed to intercept a target is done by application of the maneuvering board problem solving skill; the determination of whether radar controls are properly set is done by the skill of discriminating between radarscope presentations that indicate properly set controls from those which are not; communicating tactical signals involves the skill of using the Allied Signal Book.

OPERATIONS DUTY. A duty directly related to the carrying out of the e.g., a ship. Operations duties are tied to a specific system, e.g., sonar operator, OOD. Operations duties and tasks tend to be part of information processing sytems. This kind of a system is organized to detect environmental situations and cues, assess them in relationship to an operational purpose or mission and take appropriate action. ~~relationship to an operational purpose or mission and take appropriate action.~~

SUPPORT DUTY ASSIGNMENT. A duty which supports the operations, i.e., it is indirectly related to mission or purpose of the Navy. They are the application of a wide variety of mental and physical skills to the maintenance, repair and/or operation of mechanical, electrical, electronic equipment, personnel and logistic systems, etc. Supporting duties can be part of information processing systems, equipment systems or of no system. Welding, for example, is a complex skill used in maintaining any metal equipment or structure, i.e., welding is a supporting duty which is not tied to any system.

TASK INVENTORY (TI). The job tasks and skills that result from a job analysis, arranged in an order convenient for training purposes.

SYSTEM-SPECIFIC DUTY AND/OR TASK. A duty, the job tasks of which are controlled by an operations mission or by equipment of a particular system. These duties exist only to contribute to that system performance. Without a steam propulsion system, there would be no need for a BT. Without a CIC, there would be no need for a CICWO. Without an electronics system, there would be no ET. Without a carrier, there would be no need for a Landing Signal Officer (LSO).

SYSTEM NONSPECIFIC DUTY AND/OR TASK. A duty involving skill application that can be applied to more than one system, e.g., welder, physician, carpenter. It is oriented to the materials or the conditions of the people the technician or professional is working with, not to a particular organization.

SYSTEM ANALYSIS. In terms of an existing system, the identification of functions performed to achieve system goal(s), and the input - outputs of each component contributing to each function. In terms of the system designer, the function and components must be developed or invented to achieve the system goals. Course design is discussed in this Manual in terms of duty assignments in existing systems.

JOB ANALYSIS. The breaking of a job into a series of levels of job tasks of increasing specificity. In Navy terms, job analysis is analyzing a billet into duty assignments, these into tasks and these into task elements. In terms of this Manual, job analysis is analyzing the assignment given in the course mission into levels of job tasks. The term is the name for the analytic process.

SKILL ANALYSIS. The breaking of a skill into smaller physical and mental skills required to perform it.

TRAINING. The preparation of individuals to perform a specific duty or part thereof.

a. EFFECTIVE TRAINING. Training is effective to the degree it attains objectives relevant to the duty in the course mission. Effectiveness of training is measured by the percentage of students meeting such objectives. No matter how well irrelevant objectives are achieved, the training is ineffective.

b. EFFICIENT TRAINING. Training is efficient to the degree it attains objectives with minimum time and cost. Irrelevant as well as relevant objectives can be efficiently attained.

TRAINING PROGRAM. A series of units of instruction, which may or may not be interspersed with job assignments, aimed at an entire rating, NEC, or designation, or major unit thereof.

TRAINING COURSE. A relatively small unit of instruction aimed at a specific duty assignment or part thereof.

MAIN PART OR MAINSTREAM OF COURSE. That part of the course designed to achieve with course entrants of a specified background a specified set of end-of-course objectives derived from the duty assignment given in the mission.

REMEDIAL PART OF COURSE. That part of a course designed to remedy deficiencies in background to permit course entrants to enter the mainstream.

COURSE DESIGN. The initial development of a set of job-oriented objectives and the selection and organization of instructional material to attain these objectives effectively and efficiently.

COURSE IMPROVEMENT. Course improvement is of two kinds depending on whether course objectives are job relevant or job irrelevant.

a. OBJECTIVES RELEVANT. Improvement here consists of attaining the objectives more efficiently. This improvement is typically gradual from class to class and stems primarily from use of test results in a feedback loop.

b. OBJECTIVES IRRELEVANT. Improvement here consists of getting relevant objectives. This kind of improvement is referred to as course redesign.

LEARNING OBJECTIVE. An instructional goal of the course expressed in terms of three elements: (1) the behavioral action the student is expected to demonstrate during or at the end of the course, (2) the conditions under which this behavior is expected to be demonstrated, and (3) the specific standards to which the behavior is to be demonstrated. In this Manual, training objectives and learning objectives are synonymous.

TERMINAL LEARNING OBJECTIVE. A learning objective expressed in terms of on-the-job tasks. The standards, so far as present course design purposes are concerned, are more often than not expressed in qualitative terms.

END-OF-COURSE OBJECTIVES. A learning objective describing the behavioral action expected from the student at the end of the course. Typically, end-of-course objectives require the integration of enabling actions. End-of-course objectives are job-entry objectives when a job assignment immediately follows the course.

ENABLING OBJECTIVES. A learning objective which helps the student achieve an end-of-course objective. Action elements of enabling objectives are derived from lower level job tasks as well as from the skills required to perform either main course or remedial tasks.

LESSON PLAN OBJECTIVES. These are more specific enabling objectives developed by the instructor for achieving the end-of-course and the more significant enabling objectives given in the curriculum outline.

TEST. Any systematic and standard way of measuring student learning. Less systematic and less standardized means of so doing are referred to as estimates.

BASIC CURRICULUM OUTLINE. A series of learning objectives, each accompanied by the terminal (or job) task from which the action element is derived. The series is arranged in the order the objectives are to be substantially attained.

ADMINISTRATIVE CURRICULUM OUTLINE. The basic curriculum outline translated into the format desired for administration purposes, and arranged to show the training schedule.

The above terms will be used strictly as defined above to achieve clarity. A reader encountering difficulty in determining meaning of any part of what follows would do well to check these definitions.

3. The Ten-Step Course Design Procedure

Initial course design and course improvement can be thought of separately, the former as the derivation of a set of objectives and the selection and organization of instructional material to attain these objectives effectively and efficiently; the latter, as a gradual evolutionary process which is never complete. Even though the two can be divorced for convenience of description, in practice they should be considered as a unit--a course design and improvement unit.

The TEN STEPS in the course design process follow:

1. INTERPRET (DERIVE) COURSE MISSION
2. IDENTIFY JOB INCUMBENT TASKS
3. ESTABLISH QUALITATIVE JOB ENTRY STANDARDS
4. GROUP JOB TASKS FOR INSTRUCTIONAL PLANNING
5. DEVELOP TRAINING TASKS
6. SPECIFY THE TESTS
7. COMPLETE THE OBJECTIVES
8. ORGANIZE AND SCHEDULE THE COURSE
9. DEVELOP AND CONDUCT LESSON PLANS
10. IMPROVE THE COURSE.

It can be noted that the majority of the steps (Steps 2 through 7) are concerned with developing learning objectives, a fact which brings out their importance for good training. These steps concern the how of deriving them. While the steps are in the general order in which the main design effort will be concentrated, the order does not imply that the course designer will not be thinking of more

than one step at a time. The steps are interrelated. When the designer is interpreting the mission, he will be anticipating the job analysis; when he is doing the job analysis he will be anticipating the training tasks to which job tasks are going to be converted. When he is developing exercises, he cannot help but think about the tests he will use to measure the learning progress of the student. When he is working on developing the tests he will be thinking of how he will use them to improve the course. When he is thinking of pretests, he can hardly avoid thinking of remedial programs. Because of interrelationships of the steps the procedure has a valuable self-corrective feature. After a step is completed, working on a later step provides new insights about the earlier steps. Changes can then be made. The course designer will find this a common experience. He is especially likely to discover any job tasks omitted when he comes to instructional planning. This kind of thinking is almost forced by the step-by-step procedure.

To make it possible to read this and the following chapters in the context of the ten-step procedure, it is incorporated in Figure 10, on a fold-out page at the end of Chapter XI.

a. Step 1. Interpret (derive) the course mission. A course mission is the general objective of the course. It sets the course boundaries, guides the distinction between ship and shore training, makes clear what is relevant content, guides the task analysis by showing where to start and the distinction between main course and remedial content, and shows the place of application of what is learned. To accomplish these ends, a mission must contain a statement of, or unambiguously imply, (1) who is to be trained to perform (2) what, (3) to what degree of qualification,

(4) where, and (5) under what general conditions. Each of these elements is essential at some phase of the course design process. Further, unless all elements of the course mission are stated correctly, it will not communicate with those that send students to the course. They will either send those who have too little or too much experience and they may expect too much from the graduate. Management derives these missions. The instructor designer must interpret. If the elements are missing, his first task is to supply them or recommend that management do so.

b. Step 2. Identify job incumbent tasks. The purpose of this step is to provide the basis for stating the action elements of learning objectives. These express the goals of the course in terms of actions, conditions, and standard elements.

Learning objectives are, if developed correctly, the key to effective and efficient attainment of the course mission. Their course design purposes are to control course content, guide the instructor in the selection and organization of training materials, instructional strategies, evaluation tools, and provide the basis for continuous improvement of the course. To derive them correctly takes concentrated effort. Attempting to state objectives without going through the steps required just about guarantees an ineffective course, one loaded with irrelevant material and with significant omissions of the relevant.

By far the most important element of a learning objective is the action element; the most important feature of the action is its source. For training courses the sources of the actions are the job tasks of the duty assignment toward which the training is directed. The action element

of the learning objective is the training task used in the school situation. The conditions element is the specification of the training task. The standards element is based on measuring student learning and is expressed in terms of the tasks the student is expected to be able to do when reporting for the duty assignment for which the training is given.

What the course designer is aiming for is a complete list of learning objectives such as are given in Appendices B, D, and F. Examples are given below, in terms of the expression given them in the Basic Curriculum Outline: the shipboard (or job) task, the training task, which includes both the action and the conditions elements, and the standard.

1. SHIPBOARD TASK: Performs preliminary settings on the AN/SPA-34

Training Task: Given an unlabeled drawing of the front panel controls of the AN/SPA-34 the trainee labels each control and identifies its functions. Technical manual and class notes may be used.

Standards: No errors.

Training Task: Performs preliminary settings, from memory.

Standards: No errors.

2. SHIPBOARD TASK: Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently.

Training Task: In a classroom exercise, three slides will be displayed simultaneously depicting various CIC status boards, plots, and equipment accompanied by audio-taped transmission of sound powered telephone and radiotelephone communications. The situations will present problems of a ship steaming independently.

Information from the various sources is not always compatible. The student must (1) compare the information with displays for their compatibility; (2) detect and record plotting, display, and communications errors; (3) assess, in writing, the immediate situation as shown on the slides; and (4) state in writing what recommendation CIC should make to the bridge.

Standards: 80% accuracy.

3. SHIPBOARD TASK: Constructs mock-ups and assembles joints for TIG welding.

Training Task: Identifies and assembles L-1 lap, T-1 tee, and B-5 butt joints for TIG welding.

Standards: Assembles each of the above joints with 100% accuracy.

4. SHIPBOARD TASK: Repairs auxiliary fuel tanks (i.e., in boats) by TIG welding cracks in carbon steel for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

SHIPBOARD TASK: Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on carbon steel for acceptance in accordance with MIL-STD 278.

Training Task: TIG welds 16-gauge carbon steel plate in a tee joint in a flat position.

Standards: Passes NDT visual inspection with no rejectable defects.

Training Task: TIG welds 16-gauge carbon steel plate with a B-5 butt joint in the flat position.

Standards: Passes NDT visual inspection with no rejectable defects.

The objectives given above have several characteristics worthy of note. They are job action oriented with verbs such as inspects, cleans, constructs, installs, repairs. Some contain more than one action verb, e.g., "inspects, interprets, and evaluates." Whether one or more action is included in an objective depends on the need for separation for training purposes. If they need training independently, they should be in separate objectives; if they do not, they can be combined in one. In initial course design, one must make his best judgment on whether or not to combine. If later experience in conducting the course shows the initial judgment to be wrong, it can be corrected.

Note that more than one shipboard task can require a lesser number of training tasks (Example 4). It will be seen in the Basic Curriculum Outlines in Appendices B, D, and E that one shipboard task can require more than one training task. In fact, there is no necessary limit to the number of shipboard tasks that can be consolidated for purposes of training or to the number of training tasks that may be required to achieve one job task. Perhaps the most obvious difference is in complexity. Example 3 is relatively short. Example 2 is particularly complex. This variation is associated with the number of lower level tasks to be integrated in a job task. The action elements of end-of-course as opposed to enabling objectives are particularly prone to require such integration.

Note that some shipboard action elements are meaningless without the inclusion of how the job task is to be done, e.g., the repairing and installing actions in the three job tasks in number 4 include the how (by TIG welding) as well as reference to the welding parameters involved.

Note that the shipboard task is carried along with the learning objective. Including the shipboard tasks serves as a constant reminder to all concerned of the terminal tasks, performance of which the training course is preparing its students.

Step 2 is concerned only with identifying the shipboard tasks. It does this by job analysis methods. Identifying these job incumbent tasks can be difficult. A procedure to help in identifying job tasks is described and illustrated in this Manual. Steps in this procedure will be brought out as Step 2 is applied to specific duty assignments.

c. Step 3. Establish qualitative job-entry standards. Job-entry standards, it will be recalled, refer to the standards for job tasks. Quantitative standards for shipboard tasks are few, so by necessity these standards will be largely qualitative, i.e., expressed in general terms, hence obtained by some kind of rating technique.

The Task Inventory identifies the job tasks towards which the training is to be directed, i.e., the action elements of terminal objectives. These job tasks, however, specify what the experienced job incumbent must do successfully. Typically a course does not train for all possible job tasks; nor does it train all tasks chosen to the proficiency level that is required by the highly successful incumbent. The decision that has to be reached for each task, therefore, is whether it is to be chosen for training and, if so, to what level of proficiency. How these questions are answered will have marked effects not only on time requirements for the course but on how objectives are stated and evaluated and on the strategy of instruction. Training monitoring of watch personnel to the level of highly successful CICWO performance requires much more realistic and longer practice than training to a very minimal level of performance as a basis for rapid shipboard learning.

In making these decisions, guidance is found in the manner in which the standard for course graduate performance is stated or implied in the mission.

What this step accomplishes is to eliminate any tasks that need not be trained, and distinguish between tasks with "knowledge about" and with performance standards. It is the latter on which the course should concentrate. Students should be given guidance in learning the former by themselves.

d. Step 4. Group job tasks for instructional planning. This step moves the sequence of job tasks toward the curriculum outline. The major purpose of the step, however, is to bring together related job tasks so they can be scanned to determine which can be combined into single training tasks. If job tasks that should be combined into a single training task were not readily identified, more training tasks and tests than are needed would be specified in the accomplishment of the next step in the procedure.

e. Step 5. Develop the training tasks.[1] This step is indispensable for a successful training course. The better the training tasks the better the training will be. Job tasks are accepted as they are as the action elements of learning objectives. These are modified in no essential respect. Training tasks can range from simple to highly complex, some requiring computer-based simulation to carry them out. In the development of training tasks it will be found that the conditions elements of learning objectives emerge naturally. These training tasks must be devised so that some part of each can serve as a test to measure what the student

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[1] A reminder: training actions, training tasks, and training exercises are synonymous in this Manual.

has learned. The course designer must, therefore, think about what he will score and how, as he states each training task. Steps 5 and 2 are the really complex steps in the procedure. Effort devoted to Step 5 will be futile, however, unless the job tasks (Step 2) have been stated adequately. Step 5 requires 5 substeps:

(1) Determine which, if any, job tasks are to be simplified by use of a job aid;

(2) Complete the identification of skill tasks;

(3) Specify the training tasks;

(4) Determine whether the learning objectives need adjustment in terms of course constraints; and

(5) Determine the practicality of the training tasks or exercises specified.

Note that substep 3 is a continuation of the identification of mental and physical tasks to be trained. Skill analysis, as opposed to job analysis, has been left to this point to avoid the confusion that arises if one tries to do both a job and a skill analysis at the same time. Skill analysis can be very difficult to do, often requiring professional study. Course designers must be alert to the need for securing such help. It is after the skill tasks are identified the Task Inventory can be typed as a document.

Note also it is here that course constraints are considered. Prior to this step the information on which to base constraint decisions has not been available. Constraint decisions must be made at this point to prevent unnecessary work in later steps of the procedure.

f. <u>Step 6. Specify the tests</u>. As referred to in this Manual, a test is any systematic and standard way of judging performance. Less systematic and standard ways of appraising student learning are

referred to as estimates. A test can be based on observation of performance in accordance with a carefully prepared checklist. It can be a simple rating scale, with conditions of what and how to observe defined. It can be a score based on a standard way of administering selected parts of a training exercise. It can be, but not often in a training course, a pencil and paper test.

The need for tests for a variety of purposes is stressed by all. This point is also stressed in this Manual. What is stressed even more here, however, is the development of training exercises which serve both training and testing purposes. All that needs to be done to make a well constructed exercise a test is to give it, or part of it, under standard conditions and score it properly. That is why in the present procedure, the translation of job tasks to training tasks or exercises comes before the problem of testing to develop standards is mentioned, and why the manner of scoring is suggested in the training task. What the problem boils down to is that exercises and tests are, as the song goes, like a horse and carriage. For training purposes, one cannot exist without the other. When one is developing the exercises, he must be considering how it, or parts of it, can be constructed and scored to measure student's learning progress. Tests, in short, should be based on exercises designed to train. Tests used in a training course must faithfully reflect the job actions, the mental and physical skills to be performed. Developed in the context of the present procedure, they will do so. In this context they will also be almost exclusively performance tests.

Tests serve three training purposes: (1) improving the course, (2) individualizing instruction, and (3) evaluating the student. Of these, the first two have by far the most long run value. They serve the first purpose by telling the instructor how many students have attained standards of course objectives and how many have not. Unless the instructor finds this out, he has no solid basis for improving his methods of instruction, altering the time allotments to various aspects of instruction or otherwise improving the course.

g. Step 7. Complete the objectives. To complete the objectives, standards must be added. Having a test, how are standards to be set? The first guideline comes from the degree of qualification for job-entry performance stated in the course mission. Apart from the case where at least semi-objective standards are established by Naval authority, as they are for some NECs, setting standards on tests of performance on specific enabling and end-of-course objectives in the final analysis comes down to instructor judgment. What it amounts to is deciding what minimum is to be accepted as satisfactory. Once these minimums have been established for all objectives, they can be edited.

Having standards for each objective does not solve the problem of standards for the course as a whole. On what kind of judgment should these standards be based? The only answer that makes sense from a management point of view is on the basis of student's readiness to proceed to his duty assignment and perform to a level which does not damage equipment, endanger life, or accomplishment of the ship's mission.

h. Step 8. Organize and schedule the course. This step sequences the general order in which objectives will be attained, makes provision for introductory and review sessions, and schedules the course in a manner to achieve the flexibility required to adapt to individual differences. Sequencing is accomplished in terms of the logic of what is being trained and in terms of learning principles. Necessary introductory (of a different kind than usually given) units are inserted in the Basic Curriculum Outline as are review sessions. The Administrative Curriculum is then prepared by scheduling in a manner that permits adaptation to individual differences. This requires scheduling in large blocks of time, rather than in 50-minute hours.

i. Step 9. Develop and conduct instruction. This lesson planning step has the typical purpose of furnishing a guide to the instructor and his substitute or replacement in the instructional situation. It involves the instructor's carrying the task and skill analysis to further detail to develop even more specific learning objectives for his own guidance. It involves consideration of instructional strategies, methods, and management of each student's learning process. How much lesson planning the course designer should do and how much left for the instructor depends on the difficulty of what is to be trained and on the competence of the instructor. The analysis of perceptual-motor skills involved in welding and the discrimination skills involved in the airborne ASW operator's duty are examples of the kind of difficulty which requires the course designer to develop the complete curriculum. When no such skills are involved and the problem is only one of identifying a hierarchical series of job actions, the analysis can stop when

a job task is reached where it is certain the instructor can complete the analysis himself. The variety in training methods characteristically indicated as desirable in carrying out the ten-step procedure, and especially the scheduling to adapt to individual differences, makes necessary a corresponding variety in lesson plan format.

j. Step 10. Improve the course. This step is essentially a feedback step, based on the information from tests of what students have learned. Reasons for failure are investigated, causes found, changes made and evaluated. Time allotments of course units are adjusted in terms of such feedback information. Step 10 is mandatory for maintaining continuous improvement of a course.

4. Organization of the Manual

~~Except for a concluding discussion chapter,~~ The remainder of the Manual consists of a detailed discussion of each of the ten steps in terms of the design of courses for three quite different duty assignments: a CICWO, an electronic equipment maintenance technician, and a welder. The discussion will bring out differences in course design that occur as a result of differences in the nature of the duty assignment.

Considered in terms of the principles underlying the ten-step procedure, differences are surprisingly minimal. How effort is distributed among the steps, and how they are interrelated do show some differences that need to be taken into account. Each chapter discusses a course design step in general terms and then the application to the CICWO, ET, and welder duty assignments, usually in that order. Some points are more readily understood with reference to one or the other of these three courses. They are discussed in the best context for comprehension. Repetition is minimized as the discussion moves from course to course, i.e., once a point has been discussed, it will be referred to again only incidentally. A chapter's contents, therefore, cannot be understood in terms of the discussion about a single course. Nor, as noted at the beginning of this chapter, can they be understood without constant reference to the Task Inventories and Basic Curriculum Outlines in Appendices A to F.

One point needs emphasis. There was a great deal of trial and error effort in developing the ten-step procedure. Insights were hindsights more often than foresights. Each course design is described, however, as though the procedure had been developed and was being applied as described herein. While this distorts the facts concerning the manner in which we proceeded, it results in a clearer presentation of what we would do now. Nor is it implied that the courses discussed will adopt completely the designs as proposed. Much has been implemented, but much remains to be done. Sufficient implementation has been accomplished, however, to have learned the procedure can be managed and results in great improvement. In short, the courses were used as a basis for the development and tryout of various parts of the design procedure and have not yet served as vehicles for complete implementation.

TABLE OF CONTENTS

CHAPTER II

STEP 1. INTERPRETING THE COURSE MISSION

Specifying the mission (the general goal of the course) may require explicit mention of as many as five elements. These are (1) who is to be trained, to do (2) what, (3) to what degree of qualification, (4) where, and under (5) what general conditions Which of these must be explicitly mentioned depends on the particular duty assignment. The who specifies the course entrant--Seaman, Fire Control Technician third class, junior naval officer, etc., from which experience requirements can be inferred, if they are not stated. Aptitude requirements must be explicitly stated. The who guides the criteria for acceptance of students; if those without full qualification are accepted, it guides the distinction between main course and remedial tasks, thus suggesting where the job analysis may stop. The what identifies the job or part of the job for which the training is to be given--CICWO, AAW evaluator, operator of electronic equipment. Hence, it tells where to start the job analysis. Degree of qualification refers to ability to perform specific job tasks at job entrance. Thus it guides the setting of the dividing point between shore and ship training. This in turn effects the length of the course. Where refers to ship type, e.g., all combatant, FRAM II type destroyer, attack carrier (CVA), specific shore locations, thus further specifying the boundaries of the course. Conditions refer to readiness conditions as well as to physical environmental conditions, e.g., extreme temperature which will effect the manner in which the job must be performed. These general conditions apply to all the learning objectives of the course. Each learning objective has its own additional conditions.

A series of illustrative missions are given below:

1. To prepare senior radarmen for qualification as combat information center supervisors aboard naval ships during all readiness conditions.

2. To prepare non-rated personnel for qualification as nozzlemen, hosemen, and messengers of a fire-fighting team aboard naval ships.

3. To prepare senior radarmen, E-5 and above, for qualification as radar control officers (RCO) aboard attack carriers, cruisers, guided missile frigates, and guided missile destroyers, during readiness condition one.

4. To prepare experienced naval officers for qualification as combat information center evaluators aboard attack carriers, guided missile frigates, cruisers, and guided missile destroyers, during readiness condition one.

5. To prepare engineering and deck chief petty officers for early shipboard qualifications as repair party leaders aboard naval vessels under all possible emergency conditions.

6. To prepare nonrated seamen and seamen apprentices to meet the practical factors requirements of signalman third class.

7. To increase a sonar operator's skill in classifying subsurface contacts to the skill level of experienced sonar operators.

The who and the what are stated clearly in every case. Numbers 1 to 5 give degree of qualification in terms that require additional shipboard training and require some interpretation by the job expert instructor. Number 6, however, pins the qualification by reference to standards in the Qualification Manual.

The where is stated for all naval ships in missions 2, 5, and 6, the duties being the same in all locations. It is restricted to combatant ships in 1, because the duty is sufficiently similar on these.

But in 3 and 4 the where is pinned down further. For these the course is also further limited to Readiness Condition I. Readiness Conditions for missions 2, 5. and 6 are omitted as inappropriate.

Course missions need to be stated and interpreted with some precision or course boundaries will be difficult to establish. Standards for course graduates will also be undeterminable. Of the five elements in the mission the one often not well specified is the where, the location of the duty assignment. This can seriously reduce the effectiveness of training as well as its efficiency. This location problem does not exist for specific equipment maintenance duties. It does exist if locations contain different varieties of equipment to be maintained. CIC watch officer's job tasks do differ from one combat ship type to another. Differences are large between destroyers and carriers. Similarly, which set of specific skills of a general technical craft, e.g., welding, and/or profession are required at one location can be altogether different from those required at another. The course designer either must try to cope with these differences in a single course, something which is generally impossible within time constraints, or training management must specify the where in a series of course missions to add up to a complete training program.

1. Mission for the CICWO Course[2]

To prepare (1) junior officers for (2) early qualification as (3) CIC watch officer on (4) combatant vessels during (5) normal steaming and Condition III.

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[2]The discussion on the CICWO course here and in later chapters owes much to Mr. T. E. Curran who carried the main burden of the early efforts in developing a Task Inventory for this course and to Mr. J. F. Brock who has continued the application of the course design procedure.

This mission contains all the five elements required, the who from which experience requirements can be inferred, the what, the degree of qualification which guides the determination of standards for specific learning objectives, the where or location of the duty and the general readiness conditions. With a mission stated in this manner, the main problems in interpretation concern "early qualification" and the "where." The former is not too difficult. The latter poses a problem with serious consequences. Time constraints, for example, for the watch officer course have resulted in restricting the training to destroyers as the most frequent assignment of course graduates. At present anyone assigned to a carrier has not been properly trained. As the course redesign proceeds, it may be possible to extend the coverage to other combatant vessels for those assigned to such. If this does not prove possible, the course mission should be changed. Condition III was not included originally. It was added because of Viet Nam requirements and may be eliminated as those requirements are reduced. As noted, such additions and deletions are easily managed for courses designed in accordance with the ten-step procedure.

2. Mission for the AN/SPA-34 Course[3]

[3]The discussion of the AN/SPA-34 course here and in later chapters is based on the work of WO-2 H. E. Clark who, under the then Officer in Charge of the ET "C" School, LT J. H. Slobodny, applied independently the procedure discussed in the first edition of this Manual to the redesign of the curriculum for the AN/SPA-34 course. Warrant Officer Clark, working with the writer, redid the design in terms of the procedure described herein, carrying it to a tentative Basic Curriculum Outline. The Task Inventory was redone by the writer, assisted by ETCs N. L. Tuck and C. A. Miess to bring it into more conformity with the principles discussed herein. The major training tasks, while not basically altered, were specified further, and some added. While these changes in the design of a course for the AN/SPA-34 have been reviewed by ETCs N. L. Tuck and C. A. Miess for technical accuracy, any errors in the changes and additions are not attributable to them. Appreciation is expressed for their cooperation and to LT T. A. Kreiger, current Officer in Charge of the ET "C" School for his willingness to release Chiefs Tuck and Miess from their regular duties for these purposes.

The course mission was defined as: To prepare Electronic Technician Class "A" School graduates and personnel with equivalent training to maintain on his own the AN/SPA-34 indicator group. Of the five elements that might be needed in a mission this one includes the who, the what, the degree of qualification (the ET must be prepared to perform the job tasks on his own). Since maintenance of a specific equipment is the same no matter where it is located, the where element is irrelevant for the duty. Similarly, maintenance of equipment is not influenced by readiness conditions, nor in this case by special environmental conditions (e.g., artic). Hence, the general conditions element is not required in the mission of this duty assigment.

Interpretation of this mission for course design purposes presents no special problem. In this instance it is a specific equipment, the AN/SPA-34, the maintenance of which is being trained. ETs, however, are frequently assigned to maintain all the electronic equipment on a ship or ship type. The location problem can then become serious and raise questions about training program design.

3. Mission for a TIG Welding Course[4]

Crafts such as welding, which include many subskills, raise the location problems in extreme form. In the Navy, the problem is frequently associated with the specification of NECs. Courses are designed to qualify or prepare students for qualification in a particular NEC. If the skills included in an NEC are not those required where course graduates are assigned, training is ineffective. In welding, for example, the problem

[4] The discussion of the welding course here and later is based on, and owes much to the work of Drs. M. L. Abrams and J. A. Caviness, as well as to DCCS H. D. Le Roy.

becomes one of determining <u>what kind</u> of welding skills are required <u>where</u>. Once this is determined the mission of welding training courses can be defined in terms of a training program so that particular training courses prepare for particular duty assignments. What this means is that all job tasks requiring welding must be identified, along with the particular welding subskill involved, for the entire Navy before an effective series of course missions can be developed. This was done before the mission of the TIG welding course, used to illustrate the course design procedure, was stated. How the job tasks were identified will become clear as the course design steps are discussed. On the basis of identifying all welding tasks required by the Navy, six NECs, with corresponding course missions were defined. The missions are:

<u>Fuel Gas Welding Course</u>:

To prepare SFs (SFs with a combined ARI-MECH of 105 or "A" school graduates) for NEC 4951. SFs with this NEC: (1) silver braze on Class P-3A or P-3B ferrous and nonferrous piping systems, and (2) structural braze weld and fuel gas weld on Class E and F ferrous and nonferrous metals in accordance with NAVSHIPS 0901-920-0003 (NSTM 9920).

<u>Plate Welding Course</u>:

To prepare eligible Shipfitters (SFs with a combined ARI/MECH of 105 or "A" School graduates) for NEC SF 4952. SFs with this NEC: (1) MMA weld category C, D, E, and F welds on steel alloy plate, (2) MIG weld category E and F welds on aluminum plate, and MMA and TIG weld category E and F welds on ferrous and nonferrous metal plate as per NAVSHIPS 0901-920-0003 (NSTM 9920).

<u>Pipe Welding Course</u>:

To prepare eligible shipfitters (SFs with NEC SF 4952) for NEC SF 4954. SFs with this NEC MMA weld: (1) category C, D, E, and F welds on carbon steel piping system, and (2) category E and F welds on copper nickel piping system as per NAVSHIPS 0901-920-0003 (NSTM 9920).

High Pressure Pipe Welding Course:

To prepare eligible Shipfitters (SFs with NEC SF 4954) for NEC SF 4955. SFs with this NEC MMA weld: Category C, D, E, and F welds on carbon molybdenum and chromium molybdenum piping systems as per NAVSHIPS 0901-920-0003 (NSTM 9920).

Nuclear Plant Components Welding Course:

To prepare eligible Shipfitter (SFs with NEC SF 4955) for NEC SF 4956. SFs with this NEC: MMA and TIG weld on nuclear power plant components as per NAVSHIPS 250-1500-1.

Pressure Hull Welding Course

To prepare eligible Shipfitters (SFs with NEC SF 4952) for NEC SF 4953. SFs with this NEC MMA weld category A, C, D, E, and F welds on steel alloy plate as per NAVSHIPS 0901-920-0003 (NSTM 9920).

Course missions defined in terms of NECs naturally have a different format. The who, what, and standards are the only three components, the where having been taken care of in defining the NEC. There is no need to specify any general conditions.

The job tasks covered by each mission can be found in Abrams, Bishop & Le Roy (1969). To illustrate the course design procedure the TIG welding unit of the plate welding course (NEC SF 4952) is considered for our purposes as a complete course. The mission is that of the TIG requirements of the plate welding course. The mission becomes: To prepare eligible Shipfitters (SFs with a combined ARI/MECH of 105 or "A" School graduates) to TIG weld category E and F welds on ferrous and nonferrous plate as per NAVSHIPS 0901-920-0003 (NSTN 9920).

TABLE OF CONTENTS

CHAPTER III

STEP 2. IDENTIFYING JOB INCUMBENT TASKS

The essence of course design is the development of good learning objectives. The essential element of each learning objective is the action element. The action elements are developed from the job tasks, and these are obtained by a job analysis of the duty described in the course mission.

1. The Job Analysis Procedure

Job analysis is a logical analytic process. Its goal is to obtain a list of all the job tasks for which training is required to perform the duty assignment given in the course mission. In doing a job analysis one starts with this duty assignment and asks, "What must the job incumbent do to perform this duty?" Note that the question is asked in terms of what the job incumbent must do, and NOT in terms of what he must know. The answer to this question directed at a mission duty of any complexity will be in terms of broad job actions, performed by the job incumbent, which when added or integrated, result in the performance of the duty. Examples of such broad actions are, e.g. "Participates in a detail operating the main steam propulsion plant," for a BT duty; "Relieves the watch," for the CICWO duty. The job analysis question is asked again of each broad job task and the answer will be in terms of more specific tasks, e.g., "Monitors the lubrication system," for the BT; "Determines the status of the various systems in CIC prior to relieving the watch," for the CICWO. In a word, a series of job tasks at different and decending levels of scope will be identified. The questioning is continued until the lowest level tasks requiring training in the particular course are identified. The general procedure for job incumbent task identification consists of five steps:

1. Identify Level I tasks.

2. Sequence the Level I tasks to facilitate further analysis.

3. Analyze Level I tasks into Level II tasks.

4. Sequence Level II tasks for convenience of further analysis.

5. Repeat the analysis and sequence the tasks until the smallest task to be trained is reached.

Steps 1 and 2 are best accomplished in a meeting of a group of job experts, Steps 3 to 5 by one job expert working alone and having his efforts reviewed by a series of job experts, each working independently. What is meant by "sequencing" will become clear as the job incumbent task identification step is described for specific courses.

Note that the process of job task identification used in this Manual is strictly a matter of logical analysis. It concerns what the job incumbent must do. This is not always consistent with what he actually does because of the persistance of job tasks, once required but which became unnecessary when the system changed but the changes were/not incorporated into the duty assignment. In such instances, the must do is the decisive factor, not what is actually done.

A partial Tas: Inventory of a BT-2 duty assignment is given below to illustrate the job analysis procedure. One of the Level I tasks identified is: Participates in a detail operating the main steam propulsion plant. The job analysis resulted in the following list of tasks:

LEVEL I JOB TASK

1.0 Participates in a detail operating the main steam propulsion plant[6]

Analysis of Level I job task 1.0, "Participates in a detail operating the main steam propulsion plant," into

LEVEL II JOB TASKS

1.1 Operates and monitors steam generating system
1.2 Monitors expansion phase equipment, and adjusts as needed
1.3 Operates and monitors mechanical propulsion gear
1.4 Monitors lubrication system
1.5 Monitors condensation system
1.6 Monitors feed system

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[5] An extract from a job Task Inventory being developed by Dr. E. H. McAlister for the entire BT rating.

[6] Tasks identified from the analysis of this task must be performed by all BT-2s and above. At different times each will play a different role in the procedure. All must, therefore, be trained in all.

Analysis of Level II job task 1.1, "Operates and monitors steam generating system," into

LEVEL III JOB TASKS

1.1.1	Operates, inspects, and maintains steam generator
1.1.2	Monitors, inspects, and maintains oil-burning equipment
1.1.3	Monitors, inspects, and maintains air distribution equipment
1.1.4	Monitors, inspects, and maintains feed water system
1.1.5	Employs chemistry equipment
1.1.6	Monitors and inspects automatic controls

Analysis of Level III job task 1.1.1, "Operates, inspects, and maintains steam generator," into

LEVEL IV JOB TASKS

1.1.1.1	Lights off steam generator
1.1.1.2	Operates steam generator
1.1.1.3	Secures steam generator
1.1.1.4	Applies emergency procedures (casualty control)
1.1.1.5	Inspects, maintains, and repairs steam generator

Analysis of Level IV job task 1.1.1.1, "Lights off steam generator in a cold plant with auxiliary steam available, by performing (1) tasks in the following sequence," into

LEVEL V JOB TASKS

1.1.1.1.1	Establishes water level in steam generator
1.1.1.1.2	Establishes oil supply for steam generator
1.1.1.1.3	Establishes air supply for steam generator
1.1.1.1.4	Lines up vents, drains, and steam protection
1.1.1.1.5	Lights off steam generator (forms steam)
1.1.1.1.6	Secures vents
1.1.1.1.7	Realigns drains
1.1.1.1.8	Realigns steam protection
1.1.1.1.9	Maintains water level in steam generator
1.1.1.1.10	Raises steam to operating pressure
1.1.1.1.11	Opens steam stops

Analysis of Level V job task 1.1.1.1.2, "Establishes oil supply for steam generator by performing (11) subtasks in the following sequence," into

LEVEL VI JOB TASKS

1.1.1.1.2.1	Lines up fuel oil suction to pump
1.1.1.1.2.2	Lines up fuel oil heater
1.1.1.1.2.3	Lines up fuel oil supply to burner
1.1.1.1.2.4	Checks operation of quick-closing valve
1.1.1.1.2.5	Opens recirculating valve
1.1.1.1.2.6	Starts fuel oil service pump
1.1.1.1.2.7	Checks operation of relief valves
1.1.1.1.2.8	Cuts in steam to fuel oil heater
1.1.1.1.2.9	Ensures oil temperature is raised to operating temperature
1.1.1.1.2.10	Assembles fuel oil burners of lighting-off size
1.1.1.1.2.11	Installs fuel oil burners thus assembled

Note how specific Level VI tasks are. The analysis stopped at this point because, given instructions, any student will be able to do these simple tasks. They are like turning a knob to adjust a dial. Several criteria for stopping the job analysis are developed in relationship to the discussion of this step in relationship to particular courses.

It should be obvious from inspecting the BT/tasks that have been used to illustrate the job task identification problem that the job analyst is not looking for anything new, anything that he will be surprised that he does. What the job expert instructor may be surprised at, however, is that some of the important things he does, he has neglected to put in the course.[7] What is sought is a way of stating the job tasks the job expert knows he performs in such a way that it not only facilitates the job analysis, but facilitates the entire course design procedure.

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[7]Inspection of the Task Inventory for the CICWO (Appendix A) reveals a substantial proportion of "monitoring" tasks. Yet, when the course design and redesign research started, there was not a single mention of these kind of tasks nor a single exercise to train students in such tasks.

The numbering system in the BT example and its purpose will be explained in a moment.

a. <u>The importance of selecting the right action verbs for job tasks</u>. It is a must that verbs express exactly what the <u>job actions</u> are. The verbs for higher level tasks guide the further analysis. Inadequately stated Level I tasks can throw the job analysis completely off the track. Job actions also must be complete. This means that <u>how</u> they are accomplished must be included, sometimes as one or more lower level tasks, often in a single task statement. For example, job tasks for welders are <u>attach</u>, <u>repair</u>, <u>install</u>, <u>build up</u>. Welding job tasks must also contain the welding process by which these tasks are done to be meaningful, i.e., the "how" must be included. It is the writer's preference to err on the side of overexplicitness in this respect. A job task like "solders a copper wire to a lug," appears explicit, yet the verb is not really job oriented. This simple skill is not likely to cause any course design problems. The writer, however, prefers the job statement, "connects a copper wire to a lug by soldering," the verb "connect" being the job oriented <u>what</u> and the soldering being the <u>how</u>. Both are needed in the job task statement. Frequently, the point of how (by what action) the job incumbent does these tasks is missed when identifying job tasks. It can be picked up in Step 5, when specifying a training task for the job task forces one to reconsider the job task statement because of the difficulty he is having in specifying a training task.

This discussion leads to the distinction between job analysis and skill analysis. This distinction will be better understood in terms of the discussions of Steps 2 and 5 of the course design process applied to specific courses. Here, note only that Step 2 is concerned with job analysis.

Complex skill analysis is postponed to Step 5 to avoid the confusion that arises from trying to keep too many and too different things in mind at the same time.

2. Managing the Number of Job Tasks

To keep track of the job tasks and make them manageable in later steps in the ten-step procedure, two techniques are indispensable: a numbering system and a card system. The BT tasks given above illustrate the numbering system. Essentially it identifies task levels as follows:

Level I Tasks:	1.0	2.0	3.0, etc.
Level II Tasks:	1.1	2.1	3.1, etc.
Level III Tasks:	1.1.1	2.1.1	3.1.1, etc.
Level IV Tasks:	1.1.1.1	2.1.1.1	3.1.1.1, etc.

This numbering system can be easily followed in the BT illustration. Note from the BT illustration the variable number of job tasks into which any level task can be analyzed. First level Task 1.0, "Participates in a detail operating the main steam propulsion plant," was analyzed into 6 tasks; 1.1, into 6; 1.1.1, into 5; 1.1.1.1, into 11; 1.1.1.1.2, into 11. Note also how the job tasks become more and more specific as the hierarchical order is descended. Note that in this instance the tasks are primarily procedural and that each level requires the sequential integration of all the tasks into which it is analyzed.

One additional technique is required in managing the volume of job tasks. Each task should be placed on a separate card--termed the Job Task Card illustrated in connection with the discussion of the separate courses. Later steps in the procedure require several rearrangements of the job task order. If job tasks are fixed on a list, the procedure becomes unwieldy and, when they number in the hundreds, virtually impossible.

Once all the tasks have been identified, they should be fixed in a list for ready reference and for more ease in inspecting them as a unit than the Job Task Cards permit. This cannot be done, however, until after Step 5, where the complex skill tasks are analyzed.

3. Job Incumbent Task Identification for the CICWO Duty Assignment

The five steps in the general procedure for task identification were applied to develop the CICWO Task Inventory:

1. Identify Level I tasks.
2. Sequence the Level I tasks to facilitate further analysis.
3. Analyze Level I tasks into Level II tasks
4. Sequence Level II tasks for convenience of further analysis
5. Repeat the analysis and sequence the tasks until the smallest task to be trained is reached.

Meetings with job experts were held to accomplish Steps 1 and 2. Steps 3-5 were accomplished by one job expert, working alone, and having his efforts reviewed by a series of other job experts, each working independently. When disagreement among these experts concerned minor changes in wording, the Task Inventory was considered complete.

a. Identifying and sequencing Level I tasks. As noted, the goals of this step are to(1) identify in action terms (verbs) the broad tasks the job incumbent must perform to accomplish the duty assignment described in the course mission, and (2) to sequence these in a manner that facilitates the analysis into steadily more specific job tasks. The tasks must be stated in action terms, something the job incumbent does, e.g., "Relieves the watch." Just what the broad tasks should be is frequently not immediately obvious. The watch officer duty assignment can be analyzed into broad information collecting, displaying, processing, evaluating and disseminating tasks. These are not satisfactory for constructing a Task Inventory for training purposes because they are not what the CICWO broad duties actually are. Rather, information processing tasks are a generalized description of what is really done. When one starts to analyze a series of broad tasks and keeps meeting the same tasks over and over again in an apparently random manner, it is an almost certain indication that the Level I tasks have not been properly stated. When Level I tasks are well stated, they can be sequenced so that when further analysis brings out the same tasks, it does so in a way that is systematically related to the sequence, and not at all random. This kind of repetition of job tasks can be easily managed. Level I tasks that express what the CICWO does and which can be sequenced to further analysis straightforward and the repetition problem readily manageable are:

LEVEL I JOB TASKS IN FINAL CICWO INVENTORY

1.0 Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently.

2.0 Serves as a CICWO in a CIC involved in supporting a ship maneuvering in formations and screens.

3.0 Serves as a CICWO in a CIC participating in a man overboard recovery.

4.0 Serves as a CICWO in a CIC participating in a Search and Rescue (SAR) Operation.

5.0 Serves as a CICWO in a CIC involved in the prosecution of air contacts in an AAW Condition III.

6.0 Serves as a CICWO involved in prosecution of suspected submarine contacts in ASW Condition III.

7.0 Relieves the watch.

Carrying out job task 1.0 involves most of the basic tasks of the CICWO. Tasks 2.0 to 6.0 require these fundamental tasks plus some more. Task 7.0 involves all of the preceding six. The Task Inventory can be shortened by not repeating in Level II those job tasks also required in later levels. (See Task Inventory for CICWO in Appendix A for how this can be managed).

It takes some trial and error to discover the way Level I tasks should be stated. If the course designer keeps firmly in mind that what he wants is the broad tasks actually performed by the job incumbent, these to become the action elements of his end-of-course learning objectives and sequenced to eliminate unnecessary duplication in completing the job analysis, he will be able to discover a good way of stating them. The purpose of holding the meeting of job experts suggested on page III-4 is to assist in stating the broad tasks and sequencing them. The insight on how to state broad tasks seems to come from listing and discussing job tasks of all levels until patterns become evident. If the course designer is still finding it difficult to identify Level I tasks, another technique can be tried. He should simply state all the shipboard tasks to be trained he can think of and put these on Job Task Cards. By arranging and rearranging the cards, he may get a cue on how Level I tasks should be stated. Two things are certain.

First, as a course designer works at stating the job tasks, he will think of more and more and gain insight into their order. Second, an incomplete or poorly arranged list of job tasks is far better than no list at all in developing a training course.

b. Identifying and Sequencing lower level tasks. Just as Level I tasks should be clearly distinguishable from each other, lower level tasks should be distinguishable from tasks above, below, and at the same level in the job task analysis hierarchy. To put this another way, a job task should be so stated that the integration of performance of all at one level adds up to the accomplishment of the task above them and can be analyzed into the job tasks that add up to it. Identification of Level II tasks from Level I tasks, Level III from Level II, and so on proceeds by asking the standard job analysis question. As tasks that are repetitions of those that have been met, they can be identified by the phrase, "same as 1.1.2" or whatever the number was of the task when originally encountered, and numbered appropriately in the hierarchy of job tasks. The Task Inventories in Appendices A, C, and E, show a number of ways of doing this.

Just as with Level I tasks, all tasks at lower levels should be identified and sequenced before analysis of any into tasks at the next level. If all tasks at a level are not identified, one cannot take

advantage of the correct sequencing to facilitate the further analysis. As one moves toward the more specific tasks at the lower levels of analysis, however, the sequence makes less difference, e.g., it makes little difference from a job analysis point of view whether the task "monitors surface search operator in the search for and detection of surface, subsurface, and low flying air contacts and the processing, display, and reporting of contact data," is analyzed further before or after the task, "monitors intercept search operator in search for and detection of electronic emissions, and the processing and reporting of intercept data."

For each CICWO Level I job task, starting with 1.0 and continuing in order to 7.0, the essential question, "<u>What must the job incumbent do to perform this task?</u>" was asked. The answer for task 1.0 follows:

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 1.0

<u>Level I Task</u>

1.0 Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently.

<u>Level II Tasks</u>

1.1 Monitors[8] CIC personnel during a normal steaming CIC watch on a combatant ship steaming independently.

1.2 Evaluates the CIC information of a ship steaming independently.

1.3 Recommends to Conn all maneuvers and/or other actions required of own ship steaming independently.

Answers for the job tasks 2.0 to 7.0 were:

<u>Level I Task</u>

2.0 Serves as a CICWO in a CIC involved in supporting a ship maneuvering in formations and screens.

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[8] To monitor means to detect and correct errors of the men and machines under one's supervision.

Level II Tasks

2.1 Monitors CIC personnel involved in supporting a ship maneuvering in formations and screens.

2.2 Evaluates the CIC information of a ship steaming in formations and screens.

2.3 Recommends to Conn actions required of own ship to complete an ordered maneuver.

Level I Task

3.0 Serves as a CICWO in a CIC participating in a man overboard recovery.

Level II Tasks

3.1 Monitors CIC personnel participating in a man overboard recovery.

3.2 Evaluates CIC information of ship involved in a man overboard recovery.

3.3 Recommends to Conn all required maneuvering actions and whistle signals based on CIC man overboard data.

Level I Tasks

4.0 Serves as a CICWO in a CIC participating in a Search and Rescue (SAR) mission.

Level II Tasks

4.1 Monitors CIC personnel participating in a SAR mission.

4.2 Evaluates a distress or emergency call on a CIC radiotelephone speaker.

4.3 Recommends to Conn what maneuvers should be utilized to conduct a particular SAR mission.

Level I Task

5.0 Serves as a CICWO in a CIC involved in the prosecution of air contacts in an AAW Condition III.

Level II Tasks

5.1 Monitors CIC personnel involved in prosecution of air contacts in an AAW Condition III.

5.2 Serves as AAW Evaluator in an AAW Condition III.

5.3 Recommends to Conn when ship should go to General Quarters.

Level I Task

6.0 Serves as a CICWO in a CIC involved in the prosecution of suspected submarine contacts in ASW Condition III.

Level II Tasks

6.1 Monitors CIC personnel involved in the prosecution of a suspected submarine contact in an ASW Condition III.

6.2 Serves as an ASW Evaluator in an ASW Condition III.

6.3 Recommends to Conn the appropriate maneuvers to place own ship in position to conduct urgent attacks or evade detection as applicable.

Level I Task

7.0 Relieves the watch.

Level II Tasks

7.1 Checks stored data prior to relieving the watch.

7.2 Determines the status of the various systems in CIC prior to relieving the watch.

The complete Task Inventory is given in Appendix A.

It can be noted that with the exception of Task 7.0, "Relieves the watch," the Level II tasks follow a pattern so far as the nature of the first level task permits: monitoring, evaluating, recommending. It is believed this pattern is applicable to many officer duty assignments.

The sequence is clear: the CICWO first monitors to be sure the information he has is correct, then he evaluates, and finally he takes internal action or recommends external action. These tasks clearly represent the essence, the "guts" of the CICWO duty, and the higher level tasks which combine them and will be the ones which become the source of the action elements of end-of-course learning objectives for the course.

Each job task is written on a separate card, termed the Job Task Card. An example is given in Figure 1. Note how the task statement was changed and renumbered. This frequently happens because of the self-corrective feature of the procedure. A 5" X 8" card or pad sheet has been used for the Job Task Card in order to have room for such correction. The use of this size rather than smaller is advocated not only for the reasons just given, but because some job tasks require lengthy statements.

A Training Task Card is also required. This is not developed until Step 5. The Training Task Card, companion to Job Task Card 1.2.2.1, is illustrated here for convenience of the reader. The Training Task Card, it will be noted, contains a complete learning objective.

2.1.10b	Determines, when Rules of the Road situation exists, the type of situation and the status of own ship under the appropriate rules. (1)
2.16.1	Determines that a risk of collision exists for own ship and a surface contact. (1)
2.2.2.1	Same task statement.
1.2.2.1	Same task statement.

Fig. 1. Job Task Card

Shipboard task numbers: 1.2.2.1, 1.2.2.2.1

Training task: Determines if a risk of collision exists with another vessel and, if so, what action is required in accordance with the Rules of the Road; given a series of classroom slides depicting five situations with various DRT traces and radarscope presentations.

Standards: Responds with 100% accuracy to specific questions about the situations, in writing.

Fig. 2. Training Task Card

c. Illustration of the logic of job analysis. Job tasks are derived in terms of a strictly logical analysis. Job experts, however, do many things because of tradition or because one of their subordinates is missing or at critical points in operations is unable to perform his job tasks. An example of the logic required is provided by

the unanimity with which job experts reported the solving of maneuvering board problems as a relatively high level CICWO job task. Strict adherence to a logical analysis of the duty assignment reveals that the CICWO estimates solutions from a radarscope, that he monitors the maneuvering board solutions of the maneuvering board operator, estimates CPA, course and speed of target ship, and detects incompatibilities between solutions to the problem, none of which necessarily requires him to solve maneuvering board problems. Query brought out the fact that the CICWO frequently had to serve as his own maneuvering board operator. The task "serves as maneuvering board operator," was included in the Inventory and thus the logic of the analysis with the experience of the job experts was reconciled.

Both the maneuvering board operator and the CICWO duty assignments, require skills in relation to solving maneuvering board problems. What each uses these skills for is not the same. The more complex tasks from which the specific maneuvering board tasks are derived will determine in what ways the two sets of maneuvering board tasks are stated differently for each of the duties. The maneuvering board plotter must be able to solve problems of desired course and speed quickly and accuratly to

confirm actions already started. The CICWO duty assignemnt requires the monitoring of the maneuvering board plotter to ensure accuracy of his solutions. This higher level monitoring task requires the CICWO to compare the maneuvering solution with information on the DRT, the radar-scope and integrate this with information about the situation he has obtained or can obtain from other sources. This kind of integration is the essence of the CICWO duty but not that of the maneuvering board plotter. The job task identification must clearly distinguish between the job tasks of two positions as different as these.

In turn, the maneuvering board problem solving task should not be included in a CICWO Task Inventory unless he must serve as his own maneuvering board operator and hence must learn maneuvering board operator job tasks <u>or</u> unless the monitoring task of the CICWO requires for its accomplishment the ability to solve maneuvering board problems, albeit not with the same speed. In this particular case, it is probably necessary that a CICWO be able to solve maneuvering board problems but not with the same speed as a maneuvering board operator, in order to perform his job task of monitoring the solutions of the maneuvering board operator and comparing them with DRT solutions. Judgments on these matters must be made by the course designer, but should be checked by empirical studies in order to increase the efficiency of training.

d. <u>Criteria for stopping the analysis</u>. The job task identification is stopped when all tasks that are to be trained are identified. There are four rules for recognizing the most specific task to be trained to prepare for a duty assignment like the CICWO: (1) stop when the job tasks clearly and accurately express what needs to be trained; (2) stop when further analysis involves a complex skill, e.g., MMA welding; (3) stop when a task is reached the designer is confident the job expert instructor can analyze into all the lower level tasks; and (4) stop when a job task is reached the course entrant is supposed to be able to do.

(1) <u>Action verbs should express exactly what needs to be trained</u>. While all action verbs in job tasks must do this, the principle appears particularly applicable as a criterion for stopping the analysis. An example of a task statement that could mislead for training purposes (remember the job task is the source of the action element of the learning objective) is, "<u>detects incorrectly set controls on a surface radar repeater</u>." This, at first sight, appears an adequate statement of a job action. It turns out, however, that it does not express how the job incumbent does the task and, therefore, the action that must be trained. It points towards training in the use and function of external controls. But the light in CIC is dim because of radar operations and the watch officer's usual position is not close enough to the radar to see the control settings. <u>How, then does he perform this detecting task</u>? What he can do is see the scope presentation. This has characteristics that reflect the settings of the external controls. It is these presentations he must attend to and interpret in terms of the search situation at a given moment. Hence, the task analysis was carried one step further and this task added as a lower level one: "discriminates between good and bad radarscope presentations."

Since this discrimination task does represent what the job incumbent does, is not a complex skill and <u>can be trained</u> as a unit as it stands, no further analysis is necessary even at a later step. In effect, a job oriented action which tells its purpose has been translated to another action which tells <u>how</u> the detection of improperly set controls was accomplished. This is analogous to the example of how a job task should be stated: "connects a copper wire to a copper lug by soldering."

Other illustrations of continuing the analysis until the job oriented action verb expresses exactly what is done on the job are given below:

1. Job task 1.1.1.2, Detects incorrect reporting procedures of the radarscope operator,

is an enabling task to the monitoring of the surface search radar operator that requires no further analysis.

2. Job task 1.1.1.3, Detects radarscope plotting errors of CPAs and course and speed,

is an enabling task to the monitoring of the surface search radar operator and requires analysis into two tasks to accurately express what the CICWO does to accomplish it:

a. 1.1.1.3.1, Determines size and composition of contacts from a radarscope plotting head, and

b. 1.1.1.3.2, Solves CPA of surface contact from a radarscope plotting head.

3. Job task 1.1.3.2, Detects incorrect interpretations of radio-telephone signals and makes the applicable corrections,

is an enabling task to the monitoring of the radiotelephone operator that requires analysis into the task,

1.1.3.2.1 Decodes and encodes signals in applicable signal books.

It is from this last job task the CICWO course designer gets the information needed to develop a training task that will train the CICWO to detect these radiotelephone operator errors. This is the case because it is the action the job incumbent performs to achieve the higher level task it was derived from.

4. Job task 1.1.12, Monitors height finding radar operator in carrying out his assigned duties,

was analyzed into:

1.1.12.1, Compares height finding radar information with other pertinent data stored and recently collected.

5. Job task 1.2.2.2, Determines that a risk of collision exists for own ship and a surface contact.

was analyzed into:

a. 1.2.2.2.1, Evaluates DRT plot to determine Rules of the Road for a give contact situation, correlating own ship's course and speed, target position, and target angle, and

b. 1.2.2.2.2, Extracts corrects maneuvers and signals for a risk of collision from current Rules of the Road.

6. Job task 1.2.3, Reports to the CIC officer and or operations officer all atmospheric refractivity information vital to the electronic equipment of his own ship, and

was analyzed into:

1.2.3.1, Plots all applicable chart data from daily RADFO messages.

7. Job task 1.2.4, Evaluates intercepted electronic signals rapidly as to type and functions of emitter and as many other specifics as possible,

was analyzed into:

1.2.4.1, Locates electronic emission information in appropriate publications.

Again, it can be observed from these illustrations and from the job tasks in the CICWO Inventory (Appendix A) that there certainly is nothing new uncovered by the job analysis. The job tasks are simply stated in a manner that best serves their training purpose as the source of the action elements of learning objectives.

(2) Complex skill tasks are not analyzed during Step 2. As a course designer analyzes a duty assignment like the CICWO he will sometimes come to a task, the accomplishment of which involves a highly complex skill. Such is the target classification task of a sonar operator. In analyzing this task into lower level tasks one finds himself grappling with the analysis of a highly complex skill task involving operating equipment to get the most clearly interpretable output, making complex perceptual discriminations in order to interpret this output. Such analyses are so complex, often requiring professional aid (Smith et al., 1967) that they are postponed to Step 5 where concentrated attention can be given them. No such skills were encountered in the analysis of the CICWO duty.

(3) What the course entrant is supposed to be able to do. This criterion is inferred from the who in the course mission, so far as the mainstream of the course is concerned. The designator, the rate, or the NEC along with experience specified in the mission permit an inference to be made. Entrants to the CICWO course might be assumed, for example, to have learned to use R/T procedures. When the job task of using this skill in transmitting messages is reached, the analysis can stop. If remedial sections are to be offered, the analysis continues. If the course entrant can be expected to perform a task like, "selects significant submarine contact data for dissemination to various command levels," the analysis can stop. If this expectation is unlikely, the job task must be analyzed further as follows:

> Determines the reliability and significance of CIC ASW information with respect to tactical requirements.
>
> Correlates CIC data with information from stored sources.
>
> Determines, for recommendations to Conn, appropriate submarine and/or torpedo evasion maneuvers.
>
> Extracts appropriate submarine and/or torpedo evasion maneuvers from applicable publications.

If a decision is made to permit entry to the course of those who do not meet the requirements for entering the mainstream, the analysis must be continued until the smallest task to be trained in the remedial section is reached. Note that it is not only lower level tasks that are of concern here. A course entrant may be able to do one of the Level I tasks.

Identification of what job entrants can do requires pretests. Their use permits checking the decisions reached by the course designer in stating the course mission and in stopping the analysis. This is another instance of the operation of the continuous self-corrective feature of the course design procedure.

(4) The job expertness of the instructor. The less an instructor can be expected to know about the job he is training others for, the more detailed the job analysis must be. In the Navy, instructors are job experts. The designer must make a judgment on how far to go on the basis of his knowledge of the competence of the instructors who will conduct the course. A CICWO job task like "recommends to Conn what maneuvers and/or whistle signals are required for a Rules of the Road situation," can be analyzed into recommending similarly for a ship in international waters and a ship in inland waters; and these can be further analyzed into specific situations requiring specific maneuvers and/or whistle signals. But in this instance, one can be confident the job expert instructor can do this analysis himself in relation to his lesson planning. Hence, the analysis stopped with the task as stated above.

Care must be taken in applying this criterion for stopping the analysis. If the course designer has any doubt that all instructors that will be involved in conducting the course can accomplish the further analysis, he should continue to state more specific tasks. Nor can this criterion be applied to all tasks. Complex skills, particularly,require specification of even the smallest actions.

4. Job Incumbent Task Identification for the AN/SPA-34 Maintenance Duty Assignment.

The development of the Task Inventory for training purposes in maintaining the AN/SPA-34 completely parallels the job task identification step for the CICWO course. The same job analysis question was asked, the same problem in sequencing was encountered, the same procedures followed, and the same criteria for stopping were used. The existence of the Technical Manual (TM)[9] and the Maintenance Requirement Cards (MRCs) takes some of the analytic burden in identifying job tasks from the shoulders of the course designer and adds another criterion for stopping the analysis. This will be discussed later.

a. Identifying and sequencing Level I tasks. The analysis was started with the job analysis question: "What must the job incumbent do to maintain the AN/SPA-34 indicator group?" One initial way was: operates the AN/SPA-34, performs preventive maintenance, performs corrective maintenance, documents maintenance actions, and performs equipment associated tasks. Level I tasks in these terms seemed logical until the amount of repetition encountered became cumbersome to handle just as it did for the CICWO duty.

Application of strict logic showed the proper answers to be in terms of the cycle of consulting the TM, performing checks, determining the existence of a malfunction, isolating it, making the repairs/replacements/ adjustments required, and documenting them. Level I tasks in these terms follow:

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[9]For brevity the "TM" from here on is to be read "TM and/or MRCs."

1.0 Extracts information from Technical Manual (TM) and/or Maintenance Requirement Cards (MRCs) required to operate the AN/SPA-34, perform maintenance actions. (1)

2.0 Sets up, checks, and operates the following equipment [AN/USM-140c oscilloscope, AN/PSM-4c multimeter, and AN/USM-115 to trigger the AN/SPA-34] in accordance with procedure in the applicable Operator's Manual (OM): (1)

3.0 Performs checks and tests, following all equipment and personnel safety precautions. (1)

4.0 Locates source of malfunctions in the AN/SPA-34. (2)

5.0 Performs maintenance actions. (2)

6.0 Documents AN/SPA-34 maintenance actions in accordance with 3M Manual, OPNAV 43P2. (1)

7.0 Performs equipment associated job tasks. (1)

Five comments are in order. First, what is meant by Task 7.0? Equipment associated tasks should be always looked for. They will not be always found but when they are, they must be examined to determine whether their training should be included in the course or left to shipboard training or experience. As will be seen, there was one equipment associated task, the training of which could be easily fitted into the course. Second, the above Level I tasks apply to any equipment maintentenance task. They are general in application. Hence, it appears that once a good Task Inventory is constructed for an electronic equipment maintenance duty, developing one for another such duty is pretty much a matter of changing functions, and functional sections, circuitry, and components. This, of course, provides a strong reason for devoting the effort required to get a good first one.

Third, the job tasks identified in the Task Inventory again make it very clear that in analyzing duties for training purposes, the course designer is looking, not for anything new, but for a systematic way of stating the job tasks which will facilitate developing a training course in which all learning objectives are job assignment oriented and none are overlooked.

Fourth, the sequence of these Level I tasks is clear. One must look up the procedures before he operates for maintenance purposes; he must make checks before he can determine whether there is a malfunction; he must isolate the malfunction, repair it, and finally document it. Once this sequence had been determined there was little problem in completing the job analysis without repetition complications.

Fifth, this sequence of Level I tasks markedly shortened, not only the Task Inventory, but the job task statements themselves. Having Task 1.0 concern the use of the TM, it is understood to be included in all succeeding tasks. Further reference as "in accordance with the procedure set forth in the Technical Manual" becomes unnecessary, except for emphasis in the Level I or II tasks.

b. Identifying and sequencing lower level tasks. Level II tasks identified for each Level I task are:

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 1.0

Level I Task

1.0 Extracts information from Technical Manual (TM) and/or Maintenance Requirement Cards (MRCs) required to operate the AN/SPA-34, perform maintenance actions. (1)

Level II Tasks

1.1 Extracts information from the schematics, general and detailed. (1)

1.2 Extracts information from the text. (1)

1.3 Extracts information from tables. (1)

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 2.0

Level I Task

2.0 Sets up, checks, and operates the following equipment in accordance with procedure in the applicable Operator's Manual (OM): (1)

Level II Tasks*

2.1 AN/USM-140c oscilloscope to measure amplitude and time interval of signals. (1)

2.2 AN/PSM-4c multimeter to measure voltages, currents, and values of resistance. (1)

2.3 AN/USM-115 to trigger the AN/SPA-34 and to measure the RANGE RING accuracy. (1)

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 3.0

Level I Task

3.0 Performs, checks and tests, following all equipment and personnel safety precautions. (1)

Level II Tasks

3.1 Performs indicator checks as an aid in locating a malfunction. (1)

3.2 Visually inspects the AN/SPA-34 for damaged components, cracked or frayed insulation, and loose connections. (1)

3.3 Measures input-output signal characteristics of each functional section, locating test points, and using appropriate test equipment, following TM procedures and safety precautions and compares them with the theoretical. (2)

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 4.0

Level I Task

4.0 Locates source of malfunctions in the AN/SPA-34. (2)

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* Note the verb for tasks 2.1, 2.2, and 2.3 is in task 2.0.

Level II Tasks

4.1 Isolates a malfunction in the AN/SPA-34 to a functional section, following all safety precautions using the overall functional block diagram, applicable test equipment, and logical troubleshooting procedures. (1)

4.2 Isolates a malfunction to a circuit in the AN/SPA-34 locating test points and components, following safety precautions, using logical troubleshooting procedures, the schematic diagrams, and appropriate test equipment. (2)

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 5.0

Level I Task

5.0 Performs maintenance actions. (2)

Level II Tasks

5.1 Replaces damaged components, cracked or frayed insulation. (1)

5.2 Replaces or repairs printed circuit boards. (1)

5.3 Solders loose connections. (1)

5.4 Aligns and adjusts circuitry and assemblies. (2)

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 6.0

Level I Task

6.0 Documents AN/SPA-34 maintenance actions in accordance with 3M Manual, OPNAV 43P2.

Level II Task

6.1 Completes OPNAV Form 4790-2K for each maintenance performed, except those performed for daily and weekly maintenance.

LEVEL II JOB TASKS FOR LEVEL I JOB TASK 7.0

Level I Task

7.0 Performs equipment associated job tasks. (1)

Level II Task

7.1 Briefs operators on basic characteristics and accuracy of AN/SPA-34 repeater. (1)

Note that Task 6.0, documentation, breaks down into but one task, "completes OPNAV Form 4790-2K for each maintenance performed, except those performed for daily and weekly maintenance." This is all that is required, so far as the course mission is stated for our present purposes. The course includes much more about the 3-M system at the direction of BUPERS.

In stating the tasks, little difficulty was encountered. It was mainly a matter of avoiding a temptation to think in terms of equipment, its functional sections, components and circuits. In developing a Task Inventory for training purposes, attention must be exclusively focused on what the job incumbent does with and to the equipment. There is no effort at this time to analyze complex skills that must be learned. These are identified in Step 5.

The complete Task Inventory is given in Appendix C.

c. <u>Stopping the analysis</u>. The criteria used for stopping the analysis of the CICWO duty apply here. It is continued until the most detailed task, the performance of which must be learned in the course, is reached for either mainstream or remedial portions of the course, or until a task is reached the further analysis of which is unnecessary because the designer <u>can be certain</u> that every job expert instructor can continue the analysis for his lesson planning purposes.

For an equipment maintenance course there is a criterion which supplements the last. This criteria stems from the availability of the TM. That part of the analysis concerned with maintenance steps has been done by the engineers who designed the system. These are incorporated in the Manual as procedural tasks. Clearly then, when a task such as, "performs preliminary settings for the operation of the

AN/SPA-34," there is little point in listing the lower level tasks, since they are already available in the TM. There is, of course, the possibility the instructor wishes to introduce them in the Task Inventory for an instructional or administrative reason: shortage of Technical Manuals, the desirability of giving instructors and/or students a clearer view of the complete system, undiluted by the detail in the Manual or because of a need for a clearer statement of the tasks in the Manual. In the present instance, some tasks in the TM are repeated in the Inventory and some are not, the decision based on such considerations.

Task 2.1, "Sets up, checks and operates the AN/USM-140c oscilloscope to measure amplitude and time interval of signals," provides an example of the kind of decision that must be made concerning where to stop the analysis. The criterion for stopping involved here is what the course entrant is supposed to be able to do. In this case the answer was determined by the decision to provide a remedial section in the course. The reason for including a remedial section for use of test equipment is the well known fact that lack of ability to operate such equipment is a conspicuous reason for failure to keep it operating. Hence, the job analysis was continued to include the tasks required to operate the AN/USM-140c oscilloscope, the AN/PSM-4c multimeter, and the AN/USM115 to measure the Range Ring accuracy. These tasks serve as the action elements of the objective for the remedial part of the course.

Job Tasks 3.1, 3.2, and 3.3 are simply the major checks that must be made. Of these, 3.3 is the important one. It breaks down into

performing checks for the AN/SPA-34 functional blocks or sections: the power supply, sweep gate generator, AEW off-centering, etc. This step is recognized by ET instructors as the critical one in trouble-shooting.

Similarly, Task 4.0 breaks into isolating a malfunction to the functional section as the basis of the measuring tasks performed under 3.3 and then isolating the malfunction to a circuit.

Tasks 4.1 and 4.2 illustrate how a number of job tasks can be consolidated into one because of the course entrance requirements. For example, if the course were open to those with no electronic experience or training (i.e., the course combined what is regarded in the Navy as an "A" School and a "C" School course), Task 4.2 would be written, "isolates a malfunction within a functional section of the AN/SPA-34." Locating test points, following safety procedures, and interpreting schematics would be included as lower level tasks. Use of test equipment would not be, because it had been analyzed under Task 3.3. Use of safety precautions would be analyzed into the job tasks similar to those given by Pickering and Anderson (1966, pp. 82-83):

"a. Never work alone.

"b. Ground all high voltage units which have been removed from their normal location for servicing.

"c. Use warning signs when required.

"d. Follow prescribed procedures for fighting an electrical fire.

"e. Follow prescribed procedures for treating shock.

"f. Tag switches.

"g. Use one hand only when operating switches, making measurements in a circuit, operating circuit breakers.

"h. Avoid working on energized circuits, but when it is necessary to do so:

"(1) Assure ample illumination

"(2) Remove loose clothing and metallic personal accessories

"(3) Insulate self from ground

"(4) Use tools with insulated handles

"(5) Use one hand only

"(6) Use a rubber glove if nature of work permits

"(7) Have men stationed by circuit breakers or switches

"(8) Have a man qualified in first aid for electric shock standing by

"i. Use special precautions when measurements are necessary in circuits employing 300 volts or more.

"(1) De-energize circuit before connecting test equipment

"(2) Discharge high voltage capacitors

"(3) Recheck test equipment controls to ascertain that they are set correctly for measuring high voltages

"(4) Use test leads which are capable of carrying high voltages

"(5) Avoid touching test equipment or leads while reading measurements results

"(6) Have an assistant, who is standing by the switch, energize the equipment

"(7) De-energize circuit and discharge capacitors before disconnecting test equipment leads from the circuit

"j. Keep all fuse boxes, junction boxes, level type boxes and wiring accessories closed except when necessary to open.

"k. Never go aloft near antenna installations while antennas are energized."

5. Job Incumbent Task Identification for a Welding Duty Assignment

Duty assignments involving complex crafts such as welding, usable in many locations in many organizations appear to require adaptation of the course design procedure. For complex skills that are related to specific equipment / or otherwise tied to a particular organization, the course designer can proceed directly to the skill analysis in Step 5. An example of such a skill is interpretation of LOFARGRAMS by the airborne sonar operator. The greatest adaptation is required when the craft is complex and there is wide variation in the subsets of skills to be applied at different locations. Such a skill is welding. All welding job tasks required by the Navy therefore need identification before course missions can be defined in terms of the what subskills and the where they are to be applied. If, for example, all job tasks at a particular location require silver brazing and TIG plate welding, there is no point in training in manual metal arc welding or in TIG welding pipe.

The course design procedure for a complex skill like welding starts with Navy wide job task identification in order to define a series of

courses to become a training program. This puts Step 2 before Step 1 of the ten-step procedure.[10]

The missions of such a series of welding courses have been given on pages II-6-7. The way in which these missions were developed is now described. Our trial and error attempts are given in order to help clarify what is involved.

a. Developing a welder training program (Course Design Steps 1 and 2). A training program consists of a series of courses interspersed with on-the-job training and/or experience. To derive a series of course missions for a welder training program, it is necessary to obtain a substantially complete list of the welding job tasks performed at all locations. This is not as difficult as it might appear. It involves (1) identifying by location the equipment systems and structures to which welding skills are to be applied, (2) identifying in each system or structure, the points of application of each welding process and its associated welding parameters, i.e., the job tasks, (3) grouping them for course allocation, and (4) stating the course missions.

(1) Identifying the equipment systems and structures. This is readily done location by location, if necessary. In the case of welding, a broader classification was found adequate. On the basis of their experience, job experts grouped the vessels (Rundquist & Myer 1968, p. 3) substantially as follows:

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[10]The course design procedure is illustrated as though such course missions had not yet been derived. If such missions exist, the course designer should follow the course design procedure described far enough to detect incompatibilities between ship and school training or between job tasks the student can perform at graduation and that he will be required to perform on the job.

(1) Diesel and low-pressure steam ($<$ 600 psi Class P-1 system with carbon steel and CMo piping), (2) high-pressure steam ($>$ 600 psi with CMo, CrMo piping), (3) nuclear ships, (4) submarine tenders, and (5) other tenders and repair ships. Since diesel and low-pressure steam driven vessels represent substantially more than one-half of Navy ships, it is clear that if the training for the welding tasks involved can be given effectively first, and does not require as much time as the present series of courses, welders can be brought to fleet utilization more quickly. This class of vessels, therefore, was chosen for the application of the relevant parts of the course design procedure, and the initial (program) mission was stated as follows: To qualify Shipfitters E-5 and above to perform all welding tasks on diesel and less than 600 psi nonnuclear steam driven vessels.

These systems and structures were identified: (1) firemain, flushing, and associated salt water cooling systems, (2) fresh water, (3) secondary steam, drains (main, secondary and gravity), (4) fuel, (5) high pressure air (6,000 psi), (6) hydraulic, (7) main machinery, (8) auxiliary machinery, and (9) ship structures (e.g., hull superstructures, foundations, door frames, etc.).

(2) Identifying welding job tasks. The method of doing this does not start with quite the same job analysis question as used for the CICWO and ET maintenance duties. It starts with the question, "What are the points of application of what welding skills in this system or structure?" To answer this question what is termed a system scan is used. No thorough system analysis is necessary. The job expert craftsman automatically looks at any system or structure in terms of what he does to or with it. The only reason we call this a system scan is to indicate that an orderly procedure is used to be sure not to miss any of the job tasks.

A series of group meetings were held with job expert instructors. The number of these required will vary with the number of systems to be scanned and the ease of discovering the best way of stating the job

tasks. There was no problem in determining the parts of the systems or structures to be scanned to locate the welding tasks. A welder works with metal pipes and sheets as follows: he repairs and replaces sections, repairs and replaces fittings, repairs and replaces valves, builds up eroded parts. The group meetings continued until the format for stating the tasks was established. At that point one job expert completed the task identification and his work was reviewed by others working independently, just as described for the CICWO duty assignment.

While there was no problem in identifying the parts of a system or structure the welder looked at to identify the job tasks, it took some trial and error to discover a good way of stating them. This will be evident in the manner in which a job task statement evolved.

(a) The job analysis question. Note that the job analysis question is asked of the duty assignment, not the existing NEC, and it is asked in terms like this: " At what points in what equipment systems or structures are there job tasks involving the application of welding processes?" This question elicits job tasks such as the three in item 4 on page I-19. Note the verbs repair and install. Other verbs representing job tasks accomplished by welding are attach and build up. Since the tasks are those derived directly from the duty assignment, they are Level I tasks,,and they will contain the welding process and other welding parameters, e.g., metals, just as those in item 4.

These Level I tasks need no further analysis for purposes of Step 2. One does not analyze the repairing, the installing, the building up, the attaching, but the welding processes by which these are done. This requires a skill analysis. Complex skill analysis is postponed to Step 5 to avoid the confusion that arises from trying to keep too many and too different things in mind at the same time.

p. VI-1

b. Illustrating job task identification.

FIRST ATTEMPT:

1.0 FIREMAIN SYSTEM

1.1 Piping.

1.1.1 Repairs piping.

1.1.1.1 Silver brazes a lap patch on CuNi.

1.1.2 Replaces piping.

1.1.2.1 Silver brazes CuNi to bronze on a face fed socket (in fixed restricted horizontal position (FRHP) and fixed restricted vertical position (FRVP)).

1.1.2.2 Silver brazes CuNi to bronze on an insert socket (in FRHP and FRVP).

This first attempt started with a single system and identified the job tasks in terms of the repairing, replacing and building up by welding pipes, fittings, and valves, and in terms of building up, attaching, etc., large sheets of metal, i.e., plate. It is the repairing and replacing sections of the piping system that is illustrated here.

SECOND ATTEMPT:

1.0 FIREMAIN SYSTEM

1.1 Piping (Class P-3b).

1.1.1 Repairs piping.

1.1.1.1 Silver brazes a lap patch on CuNi pipe using Grade III or IV silver braze alloy for acceptance in accordance with NAVSHIPS 0900-001-7000.

1.1.1.1.1 In flat position.

1.1.1.1.2 In overhead position.

1.1.1.1.3 In FRHP.

1.1.1.1.4 In FRVP.

1.1.2 Replaces pipe sections.

1.1.2.1 Silver brazes CuNi to bronze on a face fed socket using Grade III or IV silver braze alloy for acceptance in accordance with NAVSHIPS 0900-001-7000.

1.1.2.1.1 In FRHP.

1.1.2.1.2 In FRVP

1.1.2.2 Silver brazes CuNi to bronze or an insert socket using Grade III or IV silver braze alloy for acceptance in accordance with NAVSHIPS 0900-001-7000.

1.1.2.2.1 In FRHP.

1.1.2.2.2 In FRVP.

1.3 Replaces Class P-3b sections by silver brazing CuNi to bronze on an insert socket using Grade III or IV silver braze alloy for acceptance in accordance with NAVSHIPS 0900-0001-7000.

The second attempt differed from the first in four ways.

1. Piping was referred to in terms of the Navy classification system.

2. More welding parameters were added--e.g., the alloy to be used.

3. Welding positions were broken out as separate tasks.

4. The reference in which tests and standards could be found was added. Since those for welding tasks are established by naval authority this could be readily done at this point. The addition of these standards could easily have been postponed but the job experts preferred to do it at this point.

As experience was gained in stating the job tasks, the welding parameters tended to become more and more precise in their statement and more and more expressed in the terms used in Navy regulations.

<u>THIRD ATTEMPT</u>

1.0 FIREMAIN SYSTEM

1.1 Repairs Class P-3b piping by silver brazing a lap patch on CuNi pipe using Grade III or IV silver braze alloy for acceptance in accordance with NAVSHIPS 0900-001-7000.

1.2 Replaces Class P-3b pipe sections by silver brazing CuNi to bronze on a face fed socket using Grade III or IV alloy for acceptance in accordance with NAVSHIPS 0900-001-7000.

The third attempt differed from the second in two respects:

1. The use of headings like piping, valves, and fittings, repairing, replacing, etc., was dropped by bringing them into the statement of the task.

2. The welding positions were dropped as being more appropriate for inclusion in the training tasks.

FINAL STATEMENT FOR FIREMAIN SYSTEM

1.2.1.2 Repairs Class P-3b Firemain by silver brazing copper nickel pipe to a bronze casting with an insert socket for acceptance in accordance with NAVSHIPS 0900-001-7000.

The job tasks for the Firemain system are now complete. Repairing and replacing have been combined under repairing because as the analysis continued no differences were found to exist in the welding job tasks. Each task statement contains the job task (repairing) the welding process (silver brazing) and the welding parameters (alloy, kind of socket, etc.). With this kind of statement as a model, the task identification for a complex technical/ area skill can be accomplished swiftly.

c. Grouping the welding job task for course allocation. The same job tasks to be accomplished by the same welding processes and involving the same welding parameters occur in different systems. To consolidate them it requires sorting the / Job Task Cards by welding process. This step is easily accomplished. The job tasks can then be stated as follows:

1.2.1.2 Repairs Class P-3B Main Condensate, Firemain, Flushing, Salt Water Cooling, Fresh Water, Main Circulating, Auxiliary Circulating, Fixed Foam, De-aerating Feed, and Main, Secondary and Gravity Drainage systems by silver brazing copper nickel pipe to a bronze casting with an insert socket for acceptance in accordance with NAVSHIPS 0900-001-7000.

1.2.2.2 Repairs Class P-3B Main condensate, Firemain, Flushing, Salt Water Cooling, Fresh Water, Main Circulating, Auxiliary Circulating, Fixed Foam, De-aerating Feed, and Main, Secondary and Gravity Drainage Systems by silver brazing copper nickel pipe to a bronze casting with a face fed socket for acceptance in accordance with NAVSHIPS 0900-001-7000.

These are placed on new Job Task Cards.

The four-digit task number on the ~~card~~ is a result of the number of headings used in the system scan procedure. These numbers are retained so skill derivation of the on-the-job task can be retraced. The tasks themselves are Level I tasks, not Level IV, as the four-digit number would imply for the CICWO or ET duties.

d. Stopping the analysis. There is no problem on where to stop the job identification step for the welding duty. It is when all welding applications are identified. One keeps going until he is certain no new welding tasks will appear and until the locations of their performance have been established.

The Navy-wide Task Inventory is given in Appendix G. Prior to being fixed in this Inventory, the tasks were sequenced in rough training order to permit a grouping consistent with the subset of skills required for repairing, replacing, installing, etc. purposes at the various duty assignment locations. The result of a scrutiny of this list of welding tasks was a recommendation to increase the number of NECs from three to six (Rundquist and Myers, 1968). This recommendation has been implemented and welding courses modified accordingly.

Application of the course design procedure will be illustrated by an instructional unit in the plate welding course, the TIG welding unit, termed a course for convenience. The Task Inventory for this course is given in Appendix E. The absence of systems in these job tasks is owing to the fact they concern repairing, replacing, etc., structures rather than pipes. A door frame is a door frame wherever it is found.

e. <u>Course design procedure differences for the welding as opposed to the CICWO and AN/SPA-34 maintenance duty assignments</u>. Why was it necessary to identify all Navy welding tasks before course missions could be defined and not for the other duties considered? The reason is not easy to pin down, but appears to stem from the number of different combinations of techniques or skills of a profession or craft that can be applied at different locations. That is, all welding techniques, all machinists skills, all medical skills, are not required at all locations. Welding can be applied anywhere metals are to be fused, in any organization, to any kind of equipment. Training management must identify those skills that are needed at classes of location and develop course missions accordingly. Otherwise graduates are undertrained or overtrained for where they are assigned. In contrast, the CICWO duty is specific to the Navy and to the CIC within the Navy and electronic maintenance is specific to electronic equipment.

Descriptive terms are needed to be able to point to the duty assignments which are complicated by location problems and hence require identification of all the job tasks in an entire organization, in our case, the Navy, before course missions can be defined. Those adopted for use in this Manual are <u>system specific</u> (duties such as the CICWO and ET) and <u>system nonspecific</u> (duties such as the welder). System nonspecific duties consistently involve heavy emphasis on skill analysis; system specific duties, not so consistently.

TABLE OF CONTENTS

CHAPTER IV

STEP 3. ESTABLISHING QUALITATIVE JOB ENTRY STANDARDS

Guided by the general standard given in the course mission, this step determines how the training is to be divided between the school course and on-the-job. It does this by setting job entry standards for each job task. The step must be accomplished with care, since the length of the courses will be substantially determined by the level of performance required for the job tasks. The higher the standard the longer the course.

The goal is, of course, to so allocate the training to bring the job incumbent to operational readiness in the shortest possible time. To do this one must consider capabilities of each training situation as well as the nature of the tasks. Some tasks are simply not efficiently trained in school. Some levels of proficiency are best attained by on-the-job practice. The dividing line between shore and shipboard training should be set with such considerations in mind.

One advantage of the school over the on-the-job situation is that it is possible to arrange for more concentrated practice then can sometimes be obtained during a lifetime on the job. For example, how many times will a sonar operator find a whale and a submarine sufficiently close together to give him practice in discriminating between them? For school training such events can be tape recorded, the tapes

cut apart and arranged in an order that gives concentrated practice until the discrimination is learned. The CIC watch officer can be given practice in detecting errors made by the radar operator many times more frequently than their normal occurrence by an experienced radar operator under Conditions I and III. The watch officer can be given 100 trials in setting the DRT for "man overboard" for the once he does it at sea. The radar operator can be given a greater variety and concentration of practice than he will find possible on a single cruise. Emergency tasks that occur but seldom (hopefully) on the job can often be simulated better in a school than they can be aboard ship. Sufficient practice must be given in dealing with them in order to be right the first time.

Keeping such considerations in mind the qualitative standards are determined by sorting the Job Task Cards into those which the job-entrant must perform, those he must know about, and those that can be eliminated from consideration. A rating scale of five or so steps is prepared to guide this sort.

1. <u>Qualitative Standard for the CICWO Job Tasks</u>

The rating scale used for the CICWO job tasks follows:

(IN SORTING THE CARDS, REMEMBER THAT THE SCALE STEPS APPLY TO THE NEWLY TRAINED COURSE GRADUATE AT TIME OF INITIAL JOB ENTRY.)

JOB TASK GROSS STANDARD RATING SCALE

1. Course graduate should be able to perform this task with the same speed and accuracy as an experienced job incumbent.

2. Course graduate should be able to perform this task with almost the same speed and accuracy as an experienced job incumbent.

3. Course graduate should be able to perform this task with acceptable accuracy, but less than acceptable speed.

4. Course graduate should be able to perform this task, but with less than acceptable speed and accuracy.

5. Course graduates should know what is involved in the performance of the task but need not be able to perform it.

6. Course graduate should be expected to have neither knowledge of, nor skill in, performance of this task.

The number of the rating scale should be placed in ( ) on the Job Task Card (Figure 1). After the task itself is a convenient place. The number is also entered on the Task Inventory when it is typed as a document.

The top scale categories concern performance standards, the next "knowledge about" standards and the lowest, elimination. The three performance levels range from the highest response, "as well as an experienced job incumbent," to "performs slowly but accurately." The exact statements will differ in terms of the type of duty, but generally will involve speed and accuracy of performance and/or nature of supervision required. The scale steps are assigned the numbers 1-n, 1 being the highest standard. The Job Task Cards are sorted into piles corresponding to those numbers. One is guided in sorting by the degree of qualification stated in the course mission and by one's judgment based on his job experience. Those placed in the elimination pile are put aside. This rating is included only as a check on whether the lowest level tasks identified during Step 2 turn out to be too general or too detailed, i.e., on whether task indentification stopped at an appropriate point.

No tasks in the Task Inventory for the CICWO were eliminated. All are to be taught in terms of performance standards except:

1.1.13 Interacts with CIC watch coordinator to ensure that CIC maintains an alert posture for submarine contacts and that a minimal time ensues between receipt of initial submarine contact and preparedness to prosecute contacts.

1.1.13.1 Monitors CIC watch personnel in the transition from normal watch procedures to ASW posture.

1.1.14 Supervises the implementation of radar guards, EMCON conditions, and time sharing plans, briefing watch personnel as required.

1.1.15 Supervises the watch coordinator in the performance of the following tasks:

a. Watch personnel duty assignments
b. Rotation of watch personnel.
c. On-the-job training of watch personnel.

5.4 Interacts with air intercept controller in exchange of data required by AIC and that required to maintain status boards in CIC or to report to other stations

5.5 Briefs the AAW evaluator and CIC officer and ensures a smooth transition of watch personnel in the event a higher condition of readiness is ordered.

5.5.1 Provides AAW evaluator with all pertinent air contact data when he reports ready to relieve the CICWO.

6.5 Provides ASW evaluator with all pertinent submarine contact information when he reports ready to relieve the watch.

6.6 Ensures a smooth transition of watch posture and personnel without disruption of ongoing watch activities in the event a higher condition of readiness is ordered.

These are the job tasks rated in "knowledge about" terms. It is

believed that the above job tasks can and should be learned by the student with no help from the instructor except in informal discussion sessions and in being provided handouts giving the necessary information. These handouts will contain references and perhaps some PI. Except for informing the student about what is in the handouts and what learning objectives he is supposed to meet, the responsibility for learning these "knowledge about" tasks is placed entirely on the student. These tasks appear in the Basic Curriculum Outline (Appendix B) in a special section to serve as a reminder to the instructor to prepare the necessary handouts. With the "knowledge about" tasks taken care of in this manner, instruction can concentrate on those the student must learn to <u>do</u>. It is these performance tasks that are the heart of all well designed training courses.

2. <u>Qualitative Standards for AN/SPA-34 Maintenance Course</u>

The following four-point scale was used in assigning the job-entry or end-of-course standares for the AN/SPA-34 maintenance course:

1. Course graduate should be able to perform this task with the same skill and efficiency as an experienced AN/SPA-34 Maintenance Technician.

2. Course graduate should be able to perform this task with the same accuracy but with less efficiency than an experienced AN/SPA-34 Maintenance Technician.

3. Course graduate should know that the task must be performed by an experienced AN/SPA-34 Maintenance Technician but need know only where to locate the information to perform it.

4. Course graduate should be expected to have neither knowledge of, or skill in performing, this task.

There are but two levels of performance indicated because of the manner in which the mission is stated. It states that the graduate is to be fully qualified. This was interpreted to mean the job entrant must be able to perform all maintenance tasks but with less efficiency (take more time) than the experienced AN/SPA-34 Maintenance Technician. Complex job tasks (e.g., 3.3, Measures input-output signal characteristics of each functional section, locating test points, using appropriate test equipment, following TM procedures and safety precautions, and compares them with the theoretical) were rated 2. Tasks rated higher are those concerned with use of test equipment, locating components, their assembling and dissambling, use of technical manuals, and documentation tasks that the course entrant was supposed to be able to do to some degree when he entered the course. The present course is only polishing these to a higher degree of proficiency.

A consideration arose here that had not been evident in the setting of qualitative standards for the job tasks in the CICWO Inventory. In that instance, when the CICWO had to perform the tasks of his subordinates (e.g., talker, maneuvering board operator), he had to perform them as well as the subordinate. The qualitative standard rating would be the same in either instance. No confusion about the reference of the standard arose in rating the tasks. The situation is different in the case of some of the tasks for maintenance of the AN/SPA-34. The ET must operate the AN/SPA-34 only well enough to perform his maintenance job tasks. In applying the rating scale to tasks like, "operates in semidarkness the AN/SPA-34 Indicator

Group in all modes,"

it is easy to forget that the rating is in terms of the jo. incumbent ET, not the AN/SPA-34 operator. A rating of 1 is given to this task, not because the ET must operate the AN/SPA-34 as well as an operator but as well as an experienced job incumbent ET.

There were no "knowledge about" tasks in the Inventory. Nor were any eliminated.

3. Qualitative Standards for the Welding Course

It can be observed from the Task Inventory in Appendix E that the job tasks have a standard specified in a NAVSHIPS regulation. This means that Step 3 has been accomplished by experts who determined what welding techniques are to be used for what tasks and what results are acceptable. Hence, Step 3 has been done and need not be repeated. No rating scale need be constructed.

There is, however, an implication for the division between school and on-the-job training by the manner in which training tasks are specified in terms of pipes and plates to represent the shipboard welding task. Clearly the NEC awarded can certify only that the course graduate can perform the welding processes in terms of the welding parameters specified in the Task Inventory. There will, in other words, be a transitional period of on-the-job training and/or experience while the course graduate learns to apply the skills he has learned under the job conditions he finds.

TABLE OF CONTENTS

CHAPTER V

STEP 4. GROUPING TASKS FOR INSTRUCTIONAL PLANNING

The purpose of this step is to be able to identify job tasks that can be consolidated for training purposes. Sometimes many can be so consolidated; sometimes few. The step is accomplished by sorting the Job Task Cards until satisfied that job tasks that can be trained together have been brought together. Since the exact instructional order will be established in Step 8, fine distinctions need not be made at this point. A rough order is all that is needed. One will, however, find himself thinking about Step 8 in making his decisions at this point.

Step 4 is one of the more likely places for the self-corrective nature of course design procedure to become evident. It sometimes happens, especially the first time or two that one attempts to develop a Task Inventory, that the insight into the best breakdown of the mission into broad tasks does not come until one begins to think about the tasks in relationship to instructional planning. Should a new insight occur at this point, as it did in our experience with redesigning the CICWO course, the Task Inventory should be rearranged and renumbered in terms of the new groupings.

1. Grouping the CICWO Job Tasks

The Job Task Cards for the CICWO tasks were sorted until instructors were satisfied they were in a rough sequence of the order in which they should be learned. This sorting meant that higher level job tasks were placed after lower level tasks needing to be learned before being integrated into the performance of the higher level tasks.

The result is that the job tasks, minus the skill tasks not yet identified, are in an order approximate to that in which they will be included in the Basic Curriculum Outline (Appendices B,D, and F). Since this order will be checked in Step 8, all that is necessary at this point is to get tasks that can be combined for training purposes close enough together to be identified. Tasks from different Level I tasks as well as within Level I tasks are brought together by this card sort. For example, internal and external communications tasks are derived from different complex tasks. For instructional purposes, certain of them are logically considered together as one instructional unit. Two CICWO tasks that were brought together are:

Task Inventory Number	
1.1.2	Monitors intercept search operator in search for and detection of electronic emissions, and the processing and reporting of intercept data.
5.0	Serves as a CICWO in a CIC involved in the prosecution of air contacts in an AAW Condition III.

Two other tasks, which were brought in close proximity by the sort sort were the following concerned with the formation diagram and surface summary plot.

Task Inventory Number	
7.2.1	Inspects, interprets, and evaluates surface summary plot to determine presence, location, relative motion, and degree of threat of surface contacts.
2.1.4	Monitors formation diagram keeper in maintaining all required information up-to-date on the formation diagram.

Some lower level tasks are simply a statement of the how the next upper level task is performed. Such tasks are trained together. This is the case for tasks:

1.1.1.1 Detects incorrectly set controls on a surface search radar repeater.

1.1.1.1 Discriminates between good and bad radarscope presentations.

The two are clearly accomplished by the translation into a single task (see Training Task 12 on the CICWO Basic Curriculum Outline).

These job tasks can be classified under any number of topic headings large or small. These, note, are arrived at to describe the results of the card sort, not determined in advance. Examples of topic titles for the CICWO course follow:

Concepts of CIC/Mock-up Tour
Radiotelephone Communications Procedures (Programmed Instruction)[11]
Multi-Net Communications Mock-up
Single LIne Formations Mock-up
Monitoring the Surface Radar
DRT Plotting for Man Overboard
Initial CIC Response to Man Overboard
Shipboard Response to Man Overboard
Monitoring CIC Personnel (I) (Classroom Exercises)

All topic headings are listed on the first page of the Basic Curriculum Outline (Appendix B).

2. Grouping the AN/SPA-34 Tasks

In this case, the nature of the Level I tasks resulted in an order of the Task Inventory (Appendix C) which corresponded roughly with the order of instruction. There are two major changes. The documentation task was moved forward because, although it comes later in the Inventory from a logical point of view, it must be introduced early and practiced as the maintenance actions occur. The task of briefing operators (7.1)

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[11] The parenthetical material is discussed under course organization and lesson planning.

fits in so well with the overview, learning set providing introductory unit that it too was moved forward (Step 8). In addition, instructors believed the order of functional sections, when locating malfunctions within them, could be altered with profit. Alterations made can be seen in the Basic Curriculum Outline (Appendix D). In the Task Inventory the order given in the Technical Manual had been followed as a matter of convenience.

What to do with the tasks common to each Level I task was the main problem. Should such tasks as locating information in the Technical Manual, using test equipment, and repairing/replacing be combined into separate instructional units or left where they were? They were left where they were because any rearrangement involved was better considered in terms of training principles. Hence, the problem was left to the next step in the course design procedure.

3. Grouping the Welding Tasks

Welding job tasks, it will be recalled, were identified on a Navy-wide basis in order to define the course missions of the training program. In grouping the tasks for this purpose, part if not all of the step has been accomplished. It remains only to check the sort for its job tasks belonging to the TIG mission to be sure those that can be trained together were brought together. They were brought together by welding process in sorting to obtain the course mission, within processes by pipe and plate, and within these by metal.

TABLE OF CONTENTS

FIGURES

CHAPTER VI

STEP 5. DEVELOPING TRAINING TASKS

At this point in the ten-step process attention turns from the job to training for it. What has been accomplished by the previous four steps is the identification of the action elements of the learning objectives their qualitative standards, and a rough curriculum order. The remaining six steps in the course design process are concerned with how to get the student to perform these actions in the training situation in a manner which will carry over (transfer) to the job and provide the basis for further independent learning. If the course designer makes sure that it is the job actions that are practiced in the course, this transfer will take place.

Course graduate (job-entry) standards are given in terms of "knowledge about" and performance. Training the performance standard tasks is the major reason for a training course. "Knowledge about" tasks are secondary. These are, therefore, brought together and placed at the bottom of the Job Task Card deck. They require only the preparation of guides to student self-learning, probably best done during the lesson planning step. They are not involved in developing training tasks.

For reasons of efficiency Step 5 requires the following substeps:

(1) Determine which, if any, job tasks are to be simplified by use of a job aid;

(2) Complete the identification of skill tasks;

(3) Specify the training tasks;

(4) Determine whether the learning objectives need adjustment in terms of course constraints; and

(5) Determine the practicality of the training tasks or exercises specified.

There is no point in doing a complex skill analysis if a job aid simplifies the task; nor is there any point in specifying a training task in terms of a job task when it should be specified in terms of the job aid; nor is there any point in constructing an exercise if either constraints or other practical conditions to not permit its use.

1. Determining the Need for Job Aids

Each job task should be inspected to see if its performance can be simplified by the use of a job aid.

In the three courses used as vehicles for the development of the course design procedure, there has been no occasion for the development of one. This substep is, therefore, illustrated with a job aid developed for a beginning ET course.

A job task of an ET is to "operate the AN/PSM-4c to measure AC and DC voltages and currents, and values of resistance within the accuracy guaranteed by the manufacturer for the meter." Concerning this kind of a task, Hooprich and Steinemann (1965) comment:

> "Many technical jobs, particularly those involving electronics maintenance, require working with a variety of measurement terms. These terms usually consist of a basic unit (such as ampere) and a prefix (such as micro) indicating a multiple of the unit. The technician must be able to interpret these measurement terms and to make conversions among the prefix values in order to read test instrument dials, compute circuit values, and understand technical manuals."
>
> "An experiment was conducted to determine if a simple conversion chart would be a convenient and practical aid to electronics trainees and technicians on the job." (p. 1)
>
> ". . . The major finding was that those trainees using the conversion chart did significantly better on the test than those trainees not using it, and they also did as well as experienced technicians using or not using the chart." (p. iii)

FRONT

CONVERSION CHART								
FROM ↓ TO →	MEGA	KILO	BASIC UNIT	DECI	CENTI	MILLI	MICRO	PICO MICROMICRO
MEGA		3 →	6 →	7 →	8 →	9 →	12 →	18 →
KILO	← 3		3 →	4 →	5 →	6 →	9 →	15 →
BASIC UNIT	← 6	← 3		1 →	2 →	3 →	6 →	12 →
DECI	← 7	← 4	← 1		1 →	2 →	5 →	11 →
CENTI	← 8	← 5	← 2	← 1		1 →	4 →	10 →
MILLI	← 9	← 6	← 3	← 2	← 1		3 →	9 →
MICRO	← 12	← 9	← 6	← 5	← 4	← 3		6 →
PICO MICROMICRO	← 18	← 15	← 12	← 11	← 10	← 9	← 6	

- Chart reads only from left column to right.
- "Basic unit" represents any unit of measure (ampere, volt, meter, etc.) to which a prefix (kilo, micro, etc.) may be attached.
- Arrows indicate direction to move decimal point.
- Numbers indicate how many places to move decimal point.

BACK

EXAMPLES

A. To convert 2,500,000 millivolts to kilovolts,
1. *find the box in the left-hand column labeled with the prefix "milli,"*
2. *follow the line across the chart to the box in the "kilo" column,*
3. *perform the indicated operation, i.e., move the decimal point 6 places to the left.*
4. *The answer is 2.5 kilovolts.*

B. To convert 0.35 ampere to milliamperes,
1. *find the "basic unit" box (since ampere is a basic unit) in the left-hand column,*
2. *follow the line across the chart to the box in the "milli" column,*
3. *perform the indicated operation, i.e., move the decimal point 3 places to the right.*
4. *The answer is 350 milliamperes.*

Fig. 3. Recommended Format for Prefix Conversion Chart Card (Hooprich & Steinem[illegible], 1965)

The chart is shown in Figure 3 as a matter of general interest. The wording of the job task is changed to reflect the use of the job aid by adding the how i.e., "using the prefix conversion chart."

2. Completing the Identification of Skill Job Tasks

In identifying job tasks (Step 2) complex skills required to perform the job tasks are not analyzed into their subskills in order to avoid confusion resulting from trying to do too much at once. The skill analysis must now be done and the skill tasks identified added to the Inventory. The target classification skill of the sonar operator, for example, is analyzed into its components of classifying surface or subsurface targets as the case may be and each into detection of the visual or auditory display characteristics which are significant for each classification. The threat characteristics are identified for an AAW evaluator and each analyzed into the significant recognition parameters, expressed as detection, classifying and action parameters, largely expressed in terms of weapon resources.

The skill tasks can be numbered and incorporated into the Task Inventory in a variety of ways, two of which will be illustrated in the context of the AN/SPA-34 maintenance and welding course designs. Some skill analyses are very difficult to do, even for the professionally trained. It took years of study by behavioral scientists to get a good start on training for sonar target classification. Experts are still working at it (Smith, et al., 1967). The course designer should be alert to the need for professional services in identifying skill tasks. It should not be anticipated that job experts will be able to train others in such unanalyzed complex skill tasks, without such assistance.

a. Completing the Task Inventory for the CICWO. The only skill of any complexity in this duty assignment is solving maneuvering board problems. Since it was believed the job expert instructor could analyze this skill further for purposes of his lesson planning, it was considered unnecessary to identify subskills for inclusion in the Task Inventory. They are identified by the instructor during the lesson planning step, (Step 9).

b. Completing the Task Inventory of the AN/SPA-34 maintenance assignment. Electronic maintenance does involve application of much information and theory, i.e., it has a heavy component of mental skills. It, also, involves detecting symptoms from the displays and from comparison of wave forms, i.e., there is a perceptual component. The ET must manipulate the controls of the AN/SPA-34 while inspecting the display for symptoms, i.e., there are involved both motor coordination and discrimination tasks in identifying symptoms and locating controls by knob shape. These skills were identified at this point and added to the Task Inventory. In this case it proved convenient to insert them in the Task Inventory, under the job task to which they related. The skill tasks added are:

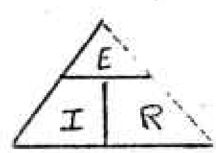
2.1.2	Sets the focus and intensity. (1)
3.1.1.1	Locates controls, relying on their shape and position for their identification. (2)
3.1.1.5	Discriminates between video signals and background noise. (1)
3.1.1.9	Discriminates between centered and noncentered presentations. (1)
3.1.2	Associates operation of external controls with functional sections. (1)

The mental skills involved in the job tasks appear to be evoked by the training tasks, providing instruction is conducted properly while the tasks are being performed. The skills needed no further analysis because of the prerequisite of "A" School attendance or equivalent experience. Had this been a course which had no experience prerequisites, there would have been a large number of such skills to be specified for the Task Inventory and for which training tasks would have to be devised. Good examples of this kind of task are found in Pickering and Anderson (1966, pp 87-90). Examples modified to fit our format are:

1. "Given examples of electricity producing apparatus (i.e., crystal earphones, phonograph pick-up, generator, etc.), identifies, without the aid of reference materials, the energy source which produces the electricity as heat, light magnetism, chemical action, or friction and the electricity produced as AC or DC."

2. "Given a schematic diagram, identifies the symbols for the various types of resistors."

3. "Using the diagram



the student applies Ohm's Law, stating the effects of changing E., I., or R. (xample, what effect does <u>increased</u> resistance (R) have upon c (I) flow.)"

4. "Measures the inc ance of an inductor, given a ZM-11/U, or equivalent, and inc ctors, including inductors with shorted turns and open windings."

c. Completing the Task Inventory for the TIG plate welder. Only the job tasks--repairing, installing, attaching, etc.--requiring TIG plate welding are identified in the Task Inventory. These are the Level I tasks. What requires analysis to identify enabling tasks is the skill of TIG welding. The skill tasks identified were 13 in number.

(1) Identifies parameters of system to be welded.

(2) Identifies, assembles, and energizes TIG inert gases and equipment.

(3) Performs routine maintenance on TIG welding equipment.

(4) Identifies and uses TIG protective equipment.

(5) Uses and interprets TIG welding reference manuals.

(6) Identifies base metals and filler metals commonly used in TIG welding and relates applicable filler metals to base metals.

(7) Constructs mock-ups and assembles joints for TIG welding.

(8) Prepares surfaces to be welded.

(9) Tack welds using TIG process.

(10) Fusion welds using TIG process.

(11) TIG welds a pass using appropriate filler material.

a. Cleans TIG pass using stainless steel wire brushes.

(12) Recognizes and repairs visible defects in a TIG welded joint.

(13) Establishes an acceptable final surface condition on TIG welded joints by removing surface scale with hand or rotary wire brush.

These were placed on Job Task Cards, as lower level tasks under task number 4.1, Task welds plate. Since these lower level tasks are the same no matter what plate is TIG welded, the skill analysis is complete. With these tasks added, the Task Inventory, it, too, is complete, and can be typed in fixed form.

The skill tasks into which the welding job task of MMA welding CFe pipe was analyzed are given as a further illustration:

1. Identifies base metals and pipe and pipe schedules used in MMA welding carbon steel (CFe) and copper nickel (CuNi) pipe.

2. Identifies filler materials and flux coatings commonly used in MMA welding CFe and CuNi pipe; relates flux coatings to filler materials and filler materials to base metals as indicated in the Master Base Material/Filler Material Tables I, II, and III.

3. Uses and interprets MMA welding pipe reference manuals.

4. Identifies and assembles a P-4 butt joint and a P-41 socket joint.

5. Tack welds (and cleans the tack welds) joint assemblies used in MMA welding CFe and CuNi pipe.

6. MMA welds a pass on CFe pipe using Mil 7018 electrode.
   a. Cleans MMA pass by chipping and grinding.

7. MMA welds a pass on CuNi pipe using Mil CuNi electrode.

8. Determines appropriate preheat, interpass and postheat temperatures and techniques.

3. Specifying the Training Tasks

Job actions in the Task Inventory become the training actions in learning objectives. The reason for taking such care in developing the Task Inventory is to identify these actions. They are never changed in any substantial way. What must be added to these are the training situations which will require the student to perform (practice) the job

actions. These training specifications become the conditions elements of the learning objectives. The remaining element of a learning objective is the standard. A training task or exercise can be the basis for obtaining this by including the manner in which the exercise can be scored. In short, training tasks specify the job or skill actions, the conditions of their training, and their scoring, so that two instructors, working independently will construct substantially the same exercise and score it in substantially the same way.

The most important learning objectives are the end-of-course so these receive first and major attention. It is the Level I tasks that usually become the action elements of end-of-course objectives. Some enabling tasks, however, are of such importance, e.g., use of test equipment by ETs, that they also should be designated as end-of-course to be certain course graduates can perform them. Job tasks selected as action elements of end-of-course objectives should be asterisked(*) in the Task Inventory, on the Job Task Cards and in the Basic Curriculum Outline.

The remainder of the discussion will be easier for the reader to follow, if he will study the job tasks and the training tasks derived from them in the three Basic Curriculum Outlines (Appendices B, D, and F).

The Job Task Cards have been sequenced (Step 4) so that tasks that can be trained together have been brought together. The course designer now checks these, makes any adjustments considered necessary. The Job Task Cards for those to be trained together can be clipped together or otherwise identified.

Training tasks must be developed to provide (1) the cues for the job actions and (2) the same kind of feedback--internal to guide perceptual-motor and mental responses, external to reinforce correct responses as provided by the job situation. How to do this varies with the nature of the job task.

Job actions with a high motor component, such as welding, carpentry, the golf swing for a professional golfer, clearly require training conditions which permit the actual actions to provide the muscle (kinaesthetic) cues to guide the motor responses. In training for such skills, the need for realistic practice is almost universally recognized. Time is not wasted in discussing the history of golf, the physics of the swing. The golf instructor gets right to the practice, and concentrates on helping the student learn the cues and establishing a feel for the muscular feedback. Training for other tasks should follow the same practice.

Job actions with a high perceptual component, LOFARGRAM ANALYSES, identifying doeppler cues in target classification, detection of properly set radar controls from radarscope appearance, estimating correct descent speed and angle of an aircraft to permit landing on a carrier, discriminating hostile from friendly aircraft, also require provision of exact stimuli. Otherwise such tasks cannot be learned. Sometimes providing such stimulus conditions can be managed rather easily, e.g., discriminating between good and poor radarscope presentation by radar repeater presentations that are adjusted and misadjusted; sonar target classification by presenting the actual visual output of airborne sonar equipment. Sometimes it may be next to impossible without unreasonable expense. To simulate the task of a crane operator could well require so much expense that it is more efficient to accomplish practically all the training on-the-job. This is the kind of question training management should have considered when establishing a course mission. When failure

to perform the job action successfully in the real world has serious consequences, expensive simulation is, of course, justified. Commercial pilot training in simulators -- to practice handling of emergencies, certainly justifies its cost. On the other hand, procedural tasks related to equipment do not need realistic simulation. If it is a matter of simple dial turning or button pushing, a crude panel is all that is needed. This has been experimentally demonstrated (Cox, et al., 1965). As cited in Crawford (1966), Cox found that "a 92-step procedure at a missile-launcher control panel can be learned as well with a small-sized drawing as with a fully operational simulator" (p. 792). Crawford concludes from this and other studies that simulation for the purpose of learning procedures need not be of a high fidelity.

Suppose, however, that the adjustment of the dials is more like fine tuning than go/no-go. If the quality of output of sonar equipment were highly dependent on fine tuning a variety of controls, the real equipment must be brought into the classroom,along with reastically simulated input to permit the operator to learn to produce the high quality output needed.

Fortunately, the need for realism is not all that complex for many tasks. The job task action "monitors radiotelephone net operators in the use of correct procedures, reporting format, and security precautions," for example, can be translated to the easily constructed training task of "detecting and correcting procedural, reporting, format and security errors made in a classroom presented audio-tape of a hypothetical radiotelephone raid reporting net."

Nor do mental tasks such as monitoring, evaluating, and deciding, especially in the early stages of learning, require expensive real-time simulation. Typical training tends to err in both possible directions for this kind of task. It either operates on the assumption that all that is needed is lecture and discussion or on the assumption that the complete environment should be created by computer-driven facilities. The latter are surely needed for training in real time to improve skills already acquired. For early learning to monitor, to decide, to recommend action, much less costly simulation is sufficient. Training exercises for such mental skills can, in fact, be developed for use under typical classroom conditions. The exercise specified as Training Task 26 in the Basic Curriculum Outline for the CICWO (Appendix B) is an example. It provides essentially the same cues and permits substantially the same response as required on the job. It provides the feedback needed for learning.

Such exercises will provide good training during the early stages of learning. At what stage such an exercise should be abandoned in favor of more realistic simulation or for on-the-job training is a problem that can be solved only experimentally.

It is quite certain such classroom exercises are much more efficient than typical mock-up[12] conditions. Most of these lose training time by requiring students to play roles other than the one for which they are being trained. In contrast, Training Task 26 permits all students to be trained full-time at the duty assignment to which they are supposed to be going. Administration of realistically simulated exercises as opposed to classroom training is also more expensive in the sense of requiring the employment of many more persons both to man the energizing equipment and to

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[12]The mock-ups referred to are replications of CIC aboard DDs, DDGs, DLGs, and CUAs. Simulation is provided by computer generated exercises furnishing coordinated inputs to all major equipment.

monitor the performance of the students. Classroom exercises, therefore, should be considered for use every time mental skills of the kind discussed here are to be trained. At a minimum they will turn out to be effective preparation for the more realistic computer-based simulation training, thus increasing total training efficiency. Sometimes they will be so effective that the graduate can proceed directly to his job for on-the-job training, eliminating altogether the training by the expensive computer-based equipment.

To sum up: the job action becomes the training action, the action element of the learning objective; the conditions of the training exercise become the conditions element. How realistically the stimuli or cues must be provided and how much of the surrounding situation and how the feedback is to be provided depends on the nature of the job actions.

The pay-off in shorebased training courses is in terms of whether its graduates learn the job better or faster than they can without it. The manner of development of the Task Inventory enhances the opportunity for this to happen by eliminating all irrelevant tasks and concentrating on performance standard tasks. The use of the job tasks as the action elements, takes a large step toward ensuring transfer from the course to the job. If these actions are evoked and practiced in the course under good instructional procedures it is just about inevitable that all that will be required is a short period of on-the-job transitional training for full transfer to take place. The more the transfer to the job, the more effective the course.

Lack of school facilities sometimes makes the problem of duplicating the essential shipboard response difficult. Lacking a live radar in the school, the job task "estimates CPA of a surface contact from a radar plotting head," must be translated into something like this: "Computes CPA of a surface contact from <u>pictures or drawings</u> of successive radar presentations." Lacking a radar that can be activated also makes it necessary to translate the task "discriminates good from bad radarscope presentations into something like this: "<u>Given a series of slides</u> in the classroom showing various surface radar repeaters with correctly and incorrectly set controls, discriminates between the two." The training tasks illustrated, while they do seem to tap the essence of the job requirements, do not permit them exactly. Therefore, it is good sense to compare the training with the pictures with training on an activated scope to make certain the training will transfer to the job. If the results are not as good as desired for the picture discriminations a further experiment can be tried, adding a transitional period of training on the live scope. The pictures plus the transitional training may be as, if not more, efficient than use of the live repeater alone.

If a realistic environmental simulation capability exists in the training activity, the instructor can make the necessary studies himself to check on whether transfer is taking place from what is being learned under cruder simulation in the classroom. To make these studies, it is essential that he obtain measures of student learning as described in the next step (Step 6).

The point that is being emphasized here is the need for determining whether transfer is indeed taking place when identical job actions cannot be evoked in the training setting. The farther one gets from

the job cues and actions, the greater the need for checking on transfer to determine whether training is accomplishing anything. It may be actually hinder the on-the-job learning.

It is emphasized again that the existence of tasks which present many problems in developing good training tasks should not be permitted to obscure the point that exact responses for many job tasks can be evoked and practiced in the classroom by simple means. The three Basic Curriculum Outlines are loaded with such easily recognizable tasks.

One further problem needs mention before discussing the development of training tasks for the courses with which we have worked. This concerns what specific trials should be put into a training task. Which best represent, or sample, those encountered on the job? The answer is simple for procedural tasks. All the procedural steps are included and practiced over and over again, if necessary, by single steps if they are sufficiently complex, but finally, always as a complete unit. For motor skills, such as welding, the skill tasks which must be practiced over and over are readily identified. For job tasks like monitoring the problem is more complex. Instances of all the job tasks that are monitored must be included. But one cannot include exactly the same instances over and over because the students will memorize them. So the instances must be varied. But one must be sure to cover a good selection, or sample, of what is to be monitored, e.g., the full range of errors that can occur with emphasis on those that occur most frequently or are the most critical to operations. Equipment troubleshooting likewise provides a good example of the need for sampling. In complex equipment, the number of things that can go wrong singly or in combination become, for practical purposes, infinite. So one must sample the instances in a manner to provide the student with the practice needed to cope with all varieties of malfunction likely to be encountered on the job.

a. Specifying training tasks for the CICWO course. The Task Inventory was examined to determine action elements of end-of-course learning objectives. All seven Level I tasks clearly should be considered as such. These are:

1.0 Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently.

2.0 Serves as a CICWO in a CIC involved in supporting a ship maneuvering in formations and screens.

3.0 Serves as a CICWO in a CIC participating in a man overboard recovery.

4.0 Serves as a CICWO in a CIC participating in a Search and Rescue (SAR) Operation.

5.0 Serves as a CICWO in a CIC involved in the prosecution of air contacts in an AAW Condition III.
NOTE: All tasks listed under 1.0 and 2.0 apply here.

6.0 Serves as a CICWO in a CIC involved in the prosecution of suspected submarine contacts in ASW Condition III.
NOTE: All tasks listed under 1.0 and 2.0 apply here.

7.0 Relieves the watch.

None of the lower level tasks appeared to need the emphasis that would be given by designating them as end-of-course. Thus, the seven Level job tasks were the only ones asterisked (*) in the Task Inventory and on the Job Task Cards.

Conventional mock-ups were available but it was felt their use would be inefficient for reasons given earlier. This decision raised the question; How can these Level I tasks be trained in a classroom? Could simulation of cues and the general tactical situation be provided to evoke and practice the job actions substantially as aboard ship? The answer was yes.

What goes into such a complex training exercise? Exactly what is indicated by the lower level tasks in the Task Inventory. The first thing to do, therefore, is to inspect the lower level tasks.

CICWO Level I job task 1.0, "Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently," will be used to illustrate the kind of thinking a course designer must do. The Level II tasks are:

1.1 Monitors CIC personnel during a normal steaming CIC watch on a combatant ship steaming independently (1)

1.2 Evaluates the CIC information of a ship steaming independently. (3)

1.3 Recommends to Conn all maneuvers and/or other actions required of own ship steaming independently. (3)

In addition, job task 1.1.9, "Monitors the dissemination of key information to both internal and external stations," was identified in Step 4 as one logically trained with these job tasks. So the exercise must be developed in terms of the five job tasks, 1.0, 1.1, 1.2, 1.3, and 1.1.9. Lower level tasks, are inspected to determine what is monitored, what is evaluated, what is recommended about, and what key information is to be disseminated. Job actions in any lower level task that are not required to be integrated in the performance of the higher level task are trained independently.

There are, in fact, but two kinds of information needed to develop complex training tasks that a well constructed Task Inventory does not provide. In terms of the Monitoring exercises the first is the representative sample of errors or decision situations that must be included. As already noted, this is no problem for procedural tasks because all steps must be, and can easily be included. It is where the possible actions and/or cues are large in number, such as in the CICWO monitoring tasks, that care must be taken in including a good representation of them in the exercise. The specification of training exercises should guide the selection of a good representation of trials, but in the last analysis the job expert who constructs the exercise will need to supply some of the judgment on what constitutes a good representation or, in more technical terms, a good <u>sample</u>, of the trials for the exercise.

The second piece of information that must be added is the general situational context in which the exercise is to take place. Sometimes this is obvious. Welding training tasks specify the metals to be used. No more is necessary. Electronic maintenance specifies the equipment to be maintained. No more is necessary. CICWO training requires a tactical situation. This is fairly well implied to the knowledgeable by the term "independent steaming." An efficient mode of supplying such a situation will be illustrated in a moment.

The Training Task (number 26) specified for the five CICWO job tasks, 1.0, 1.1, 1.2, 1.3, and 1.1.9 follows:

"In a classroom exercise, three slides will be displayed simultaneously depicting various CIC status boards, plots, and equipment accompanied by audio-taped transmission of sound powered telephone and radiotelephone communications. The situations will present problems of a ship steaming independently.

Information is not always compatible. The student must (1) compare the information with displays for their compatibility; (2) detect and record plotting, display, and communications errors; (3) assess, in writing, the immediate situation as shown on the slides; and (4) state in writing what recommendation CIC should make to the bridge.[13]

This exercise specifies how the monitoring, evaluating, recommending and communicating tasks can be practiced. It specifies the what the student will see and hear, what he should be looking for and how he should respond. It indicates what responses are to be scored. It does not specify the representative errors, the representative situations to evaluate and recommend about.[14] These are left to the job expert who is to construct the exercise.[15] It implies, but does not specify, the general tactical situation. This was presented in a booklet as well as by magnetic tape. For the Monitoring I exercise it was stated as follows:

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[13] Discussion of this exercise is based on a report by Riley and McCutcheon (May 1970).

[14] Some representative errors used were a maneuvering board solution 180° off, incompatibilities between the maneuvering board and DRT solutions, between information on displays and what is heard over the communication net, and security violations in the communications.

[15] Constructing the exercise is generally straightforward once the method of preparation is determined. An experienced RCO, given this and the job tasks, and a guide to how to select a good sample of trials can construct such an exercise as quickly as the exercise visual aids can be prepared and with very little supervision. Radarman First Class Robert M. Ragano did very well in constructing the CICWO Monitoring Exercise with this sort of guidance from Mr. Eldon W. Riley.

"You are the CIC watch officer aboard the USS ABBOT (DD 862). The voice call sign of your ship is APPRENTICE. The ship is steaming independently on course 270 true, speed 20 knots. Readiness condition Three is set. You have just assumed the 0400-0800 watch. Upon relieving the watch you were told that all electronic equipment is in good operating condition. You are maintaining a listening watch on the aircraft distress frequency on speaker No. 2, and guarding Fleet Common on speaker No. 4. After reading the Captain's Night Orders, you know that you are to maintain course and speed and proceed

to Latitude 31 degrees 30 minutes NORTH, Longitude 118 degrees 53 minutes WEST. At this position the ship will rendezvous with your Destroyer Division (DESDIV 422) at 0500. The command voice call sign is PRINCIPAL and collective voice call sign is SCHOOLBOYS. DESDIV 422 consists of the following ships in addition to your own: the USS BROOKS (DD 853) call sign BONECRUSHER, the USS CHARLES (DD 770), call sign CRUSADER, and the USS DAVIS (DD 880) call sign DEADCENTER. Commander DESDIV 422 is embarked in the USS BROOKS. The Captain's Night Orders further state that you are to maneuver in accordance with the International Rules of the Road, and if in any doubt as to what action should be taken, wake him before an extremis situation occurs. Upon reading the Radar Contact Log, you notice that the 0000-0400 watch tracked three SKUNKS all of which were detected on radar in excess of 20 miles. SKUNK B was the only contact that came within visual range and the lookouts identified the contact as the USS BLACK (DD 666). After reading the message board you see a message on which your ship is an information addressee. The message directs DESDIV 422 to join TASK GROUP (TG) 40.2 at Latitude 31 degrees 45 minutes NORTH and Longitude 118 degrees 54 minutes WEST at 0900 today. DESDIV 422 will escort TG 40.2 to WESTPAC. TG 40.2 consists of the following ships: the USS ESSEX (CVA 61) call sign KITTYCAT, USS LOS ANGELES (CL 12), call sign HOT SHOT, and the USS HELENA (CL 10) call sign PISTOL GRIP. TG 40.2 command call sign is BLACKBEARD and the collective call sign is PIRATES. The voice call signs for all units in this exercise are on a handout included in your booklet. You may refer back to this Situation Summary at any time during the exercise."

Note that this situation, while concerned with independent steaming, shows joining with a formation. Thus, it will merge with the training of the Level I task, 2.0. It can continue by encountering a submarine contact and merge with the training for Job Task 3.0. Search and rescue operations and man overboard situations can be readily provided for. In a word, this can be a continuous tactical situation for practice of all Level I tasks except 7.0, "Relieves the watch." What is being done in the CICWO course is to use such a continuously developing tactical situation divided into three parts, called Monitoring I, II, and III, lasting about ten hours for use at three different times in the course. These three exercises cover all Level I objectives except "relieve the watch" (Job Task 7.0). This is trained by an exercise running through most of the course, as can be seen by studying the Basic Curriculum Outline.

Exercises serve both test and training purposes. Use as a test is discussed in the next chapter. To use as a practice exercise, one can interrupt it for discussion. Such use, for trials which the student can memorize, requires that a large set of slides containing equivalent errors and presenting equivalent situations to be evaluated and recommended about, be constructed. This permits the instructor to draw on the particular set which meets the needs of a particular class. These equivalents are frequently easily developed. In situations such as those involving the DRT, the maneuvering board, signal encoding or decoding, location of malfunctions, formally equivalent problems are readily found. For the first two, equivalent trials are created by simply moving the ships to another quadrant of the compass or inserting the problem at an earlier or later stage in the steaming where compass points are different. For the signal book it is easy to substitute an equivalent message. For locating malfunctions, problems involving the same reasoning in relation to the same kind of circuits are readily found.

Note that the situation description contains information which will be useful in interpreting radar contacts as the ship nears the rendezvous point. In terms of this context the three displays mentioned in the training exercise can be programmed with errors to be detected and presenting situations which require evaluation and internal and external recommendations. For example, job task 1.1.5 requires the CICWO to monitor the maneuvering board operator and job task 1.2.2.2, the plotting of the DRT operator. Slide displays like those in Figure 4 illustrates one situation. In Figure 4, the DRT and maneuvering board solutions are incompatible. The student is to detect the error, make internal recommendations to correct it and when the situation progresses to a point, as it does in the exercise, requiring communication or recommendation to the Bridge, the CICWO does this.

Sufficient experience has accumulated with the training task for task 1.0 to conclude it is workable, does what it is intended to, and students respond very favorably to its realistic features.

The observant reader will no doubt have noticed that the job action is not exactly maintained in this exercise. It is written, the job task action is oral. No way could be found to permit the student to respond orally in the classroom, without enormously complicating the administration and thus increasing the cost. Since the mental response is the same and only the expression differs, it was believed that at most, a short transition period in a realistic mock-up or on the job will ensure that transfer takes place. This belief will be investigated as the opportunity arises.

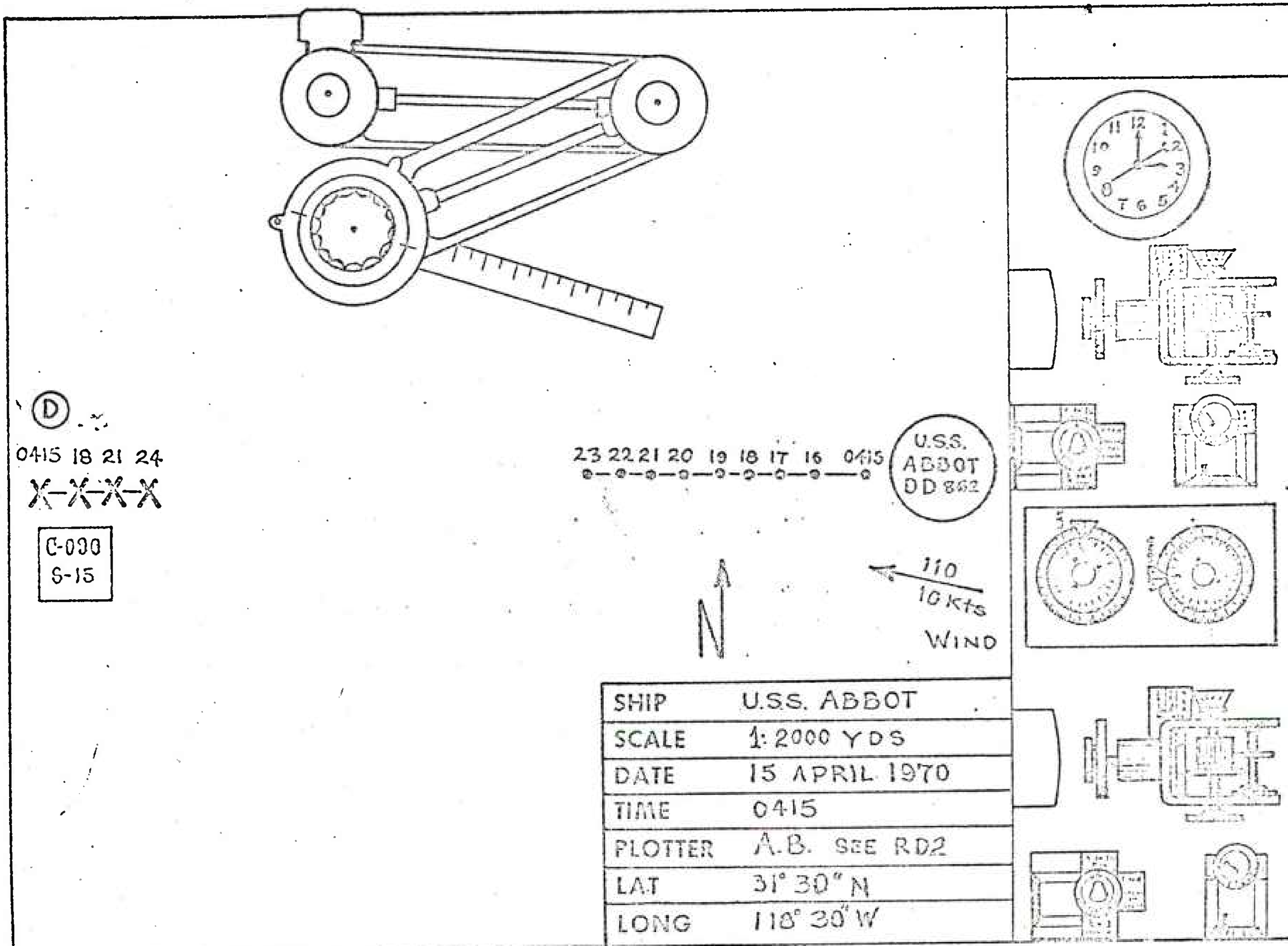

Fig. 4a. Example Situation from Monitoring I Exercise

CUS	270		AAWC	SCR CDR		WIND
SPD	20		ARRCS	SCR		D- 110
FORM			SRRCS	TYPE		S- 10
FORM AXIS			ECMCS	AXIS		T- 0415
OTC/IN						
COLL			BRG RNG	SPD TIME	NEXT SKUNK	
SKUNK	BRG	RNG	TIME	CUS/SP	CPA BRG RNG	CPA TIME
D	270	36,000	0415	090/15		
D	270	33,700	17			
D	270	31,400	19			
D	270	29,100	21			

Fig. 4b. Example Situation from Monitoring I Exercise

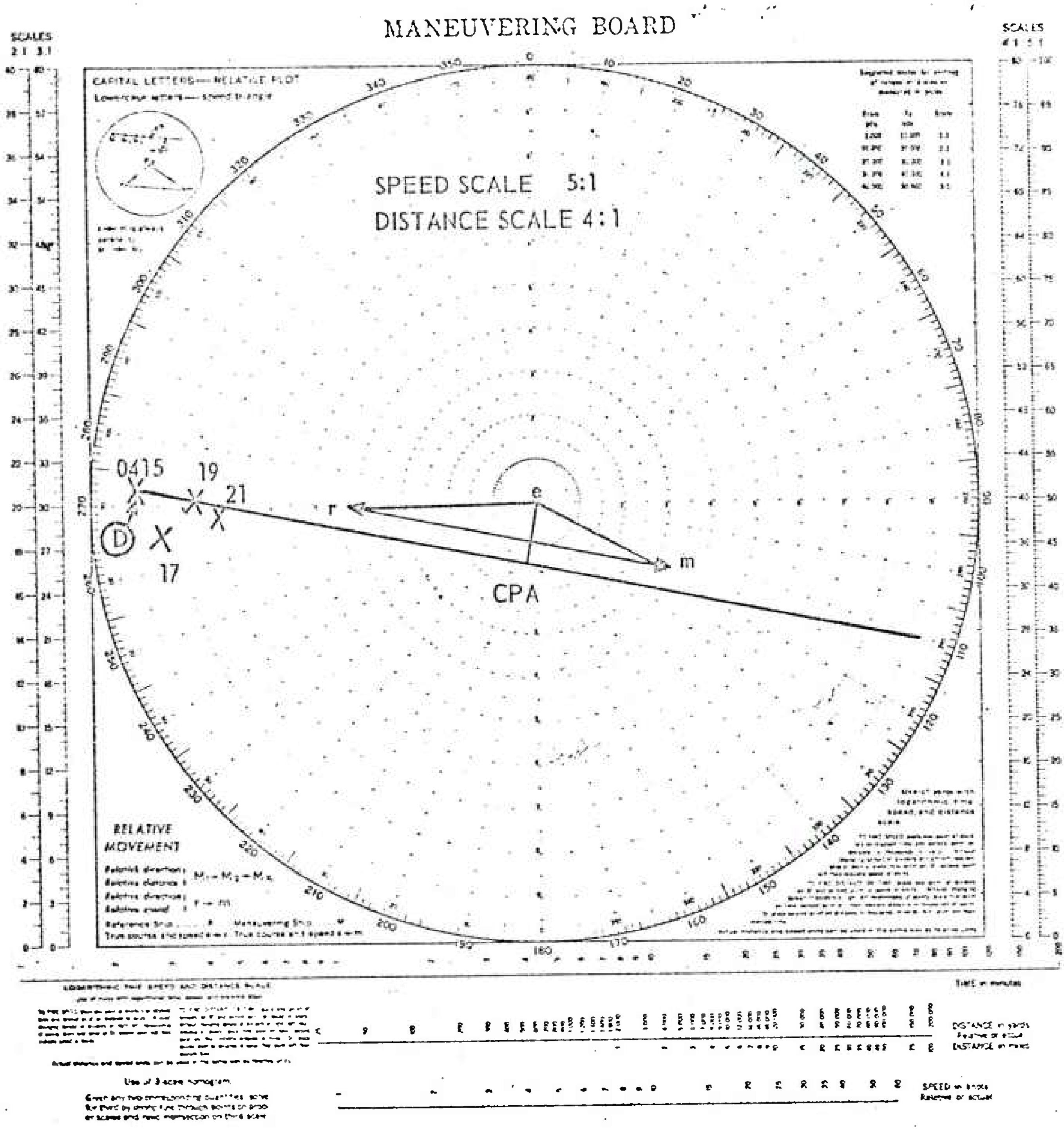

Fig. 4c. Example Situation from Monitoring I Exercise

Complex training tasks such as we have been discussing in many instances must be preceded by independent practice of the lower level tasks required, always maintaining conditions of their use in the context of larger tasks.

The question here concerns which tasks in a skill or job task hierarchy must be trained independently before being integrated with others in a higher level training task. It can be seen from the Task Inventory (Appendix A) that Task 1.0, "Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently," involves Level II tasks of monitoring (1.1), evaluation (1.2), and recommending (1.3). Are separate exercises needed for each of these three tasks before practice is given on the exercise developed for Task 1.0? It was considered that most of the tasks, Level III and below, would need separate training, e.g., 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6, 1.1.7, 1.1.8, 1.1.9, 1.1.10, 1.1.11, 1.1.12,[16] all concerned with monitoring displays and operators. With these trained independently, it is felt there would be no need for a monitoring exercise integrating them before starting the training task for Job Task 1.0. This integrates the practice of monitoring, evaluating, and recommending in one exercise. If monitoring scores turn out to be low on the integrated exercise, the need for separate training for an integrated monitoring task will need to be considered. (Step 10).

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[16] A copy of the Monitoring I exercise may be obtained by Navy personnel by writing Naval Personnel and Training Research Laboratory, San Diego, California 92152.

for most
Construction of exercises/enabling objectives presents a much simpler problem. "Estimates CPA of a surface contact from a radar plotting head," requires only the dynamic presentation on a scope or simulated scope of a sample of the solutions required aboard ship and providing them until the student can meet the course standard. "Sets the DRT to 200 yard/inch upon receiving man overboard," requires only a number of situations during which this emergency occurs unexpectedly until the student can set the DRT rapidly enough to meet the standard. In all the tasks, of course, one arranges a graded series starting with those that simply require learning the essential skills, gradually introducing the more difficult conditions. Examples are evident in the Basic Curriculum Outline.

b. Specifying training tasks for the [AN/SPA-34] maintenance course. Design of this course illustrates the desirability of sometimes elevating the status of lower level job tasks to end-of-course learning objective actions, e.g., tasks 2.1, 2.2, 2.3, 4.1, 4.2, 5.4, and 6.1 below:

1.0 Extracts information from Technical Manual (TM) and/or Maintenance Requirement Cards (MRCs) required to operate the AN/SPA-34, performs maintenance actions. (1)

2.0 Sets up, checks, and operates the following equipment in accordance with procedure in the applicable Operator's Manual (OM):

2.1 AN/USM-140c oscilloscope to measure amplitude and time interval of signals. (1)

2.2 AN/PSM-4c multimeter to measure voltages, currents, and values of resistance. (1)

2.3 AN/USM-115 to (a) trigger the AN/SPA-34 and (b) measure the RANGE RING accuracy. (1)

3.0 Performs checks and tests, following all equipment and personnel safety precautions. (1)

3.3 Measures input-output signal characteristics of each functional section, locating test points, and using appropriate test equipment, following TM procedures and safety precautions and compares them with the theoretical. (2)

4.1 Isolates a malfunction in the AN/SPA-34 to a functional section, following all safety precautions using the overall functional block diagram, applicable test equipment, and logical troubleshooting procedures. (1)

4.2 Isolates a malfunction to a circuit in the AN/SPA-34, locating test points and components, following safety precautions, using logical troubleshooting procedures, the schematic diagrams, and appropriate test equipment. (2)

5.4 Aligns and adjusts circuitry and assemblies. (2)

6.1 Completes OPNAV Form 4790-2K for each maintenance performed, except those performed for daily and weekly maintenance.

These tasks are asterisked (*) in the Inventory and on the Job Task Cards.

A question is almost certain to arise here. Since the job expert instructor may be aware of the importance of these lower level tasks identified here as the source of action elements of end-of-course objectives, why not, then, identify them as Level I tasks at the outset and start the job analyses with them. Doing so would have disturbed the logic of the analysis , in fact thrown it completely off the track, and led to much confusion in identifying the job tasks.

With job and skill tasks available their modification to become training tasks can be undertaken. "C" School equipment maintenance courses and job tasks have two characteristics highly significant for training purposes: (1) The availability of real equipment and (2) the repetitive cycles of the job tasks.

The availability of real equipment tempts the instructor to use it for all his training. This often leads to inefficiencies. Use of simulated panels, simulated displays, schematics, specially constructed equipment involving circuitry to be tested, etc., should always be considered as means of making the training more efficient. Training tasks of this kind suggested for the AN/SPA-34 course can be found in the Basic Curriculum Outline (Appendix D). Some of them are:

> Locates controls in dim light on a simulated front panel.
>
> On a simulated from front panel with adjustable and accurately positioned controls, student follows procedures to accomplish the job task as directed by instructor.
>
> In semidarkness, and as directed by the instructor, locates AN/SPA-34 controls on a simulated panel. (Controls are accurately shaped and placed.)
>
> Given pictures of indicator displays representing malfunctions, student identifies possible functional section location(s) of the malfunction, using the Technical Manual.

The repetitive cycle of job tasks, noted for the CICWO duty, exists, to an even stronger degree in equipment maintenance duties. The same tasks are exercised over and over again as part of the troubleshooting procedure.

This makes it possible to construct standard type exercises such as the following:

> With an instructor inserted malfunction, trainee will verify that the malfunction is in the SWEEP GATE GENERATOR by front panel indications and then by monitoring the input and output wave forms of the functional block. The student will then troubleshoot the SWEEP GATE GENERATOR to the stage level using logical problem solving techniques. He may use any of the supplied test equipment, the Technical Manual, and class notes. Twenty-five percent of the inserted malfunctions will be located in other functional sections. These inserted malfunctions will predominantly involve consideration of the interrelationship among functional sections. These will be located to functional block/blocks only. Malfunctions inserted will cover all components and circuit types but will emphasize those most characteristic of shipboard failures..

All that needs to be changed is the name of the functional section. Other applications of the same principle are found in the Basic Curriculum Outline (Appendix D). As the training tasks are specified, they are put on Training Task Cards as illustrated in Figure 5.

The usual problem of what to sample is found. The above exercise shows how guidance was given in the training task by the statements "malfunctions inserted will cover all components and circuit types but will emphasize those most characteristic of shipboard failures," and "these inserted manlfunctions will predominately involve consideration of the interrelationships among functional sections." Use of such

Job Task Card

3.1.1 Operates in semidarkness the AN/SPA-34 Indicator Group in all modes.

Training Task Card

Shipboard task number: 3.1.1

Training task: With equipment functioning normally, instructor directs student to perform repeated cycles of job tasks, covering all modes of operation.

Standards: Exercise continued until student completes two cycles without error in procedure, while maintaining focus and intensity adjustment at a point where instructor cannot significantly improve.

Fig. 5. Job and Training Task Cards for AN/SPA-34 Course

standard tasks capitalizes on the principle of reviewing for effective learning. The exercises cited were designed to evoke the mental skills required in troubleshooting and they appear to do so.

c. Specifying training tasks for the TIG welding course. All TIG welding tasks in the Task Inventory are Level I tasks. These have been grouped in order to define the mission of the series courses constituting the welding program. Arrangement within these groups may have been fully accomplished when skill tasks were developed. Any further adjustment required should now be made. The grouping used is evident from the Task Inventory (Appendix F).

The designation of end-of-course tasks for this kind of a course is not determined exactly in the manner it was for the two system specific courses. Clearly, fresh water, drainage, steam propulsion, nuclear systems to which a welder applies his skills are not brought into the school. What is brought in are the metals in the form of plates and pipes of various sizes and thicknesses so that the welder can peform the required welding actions just as he will aboard ship, except for adjustments needed in getting at the welding point and except for safety and other procedures associated with the parameters of the shipboard systems on which he will work. The metal plates and pipes represent the stimulus situation for welding actions. Each metal or combination of metals to be fused on the job assignment is represented in a laboratory task. The whole trick is to be sure that each significantly different application is represented so that it can be trained on-the-job. This is a matter of representing by sampling the job tasks as well as possible in the school situation.

The training tasks selected to represent the TIG welding tasks are:

1. TIG welds 16-gauge aluminum plates with a T-1 joint in a flat position.

2. TIG welds 16-gauge aluminum plate with a B-5 butt joint in the flat position.

For TIG welding carbon steel, the training tasks are:

1. TIG welds 16-gauge carbon steel plate with a T-1 joint in a flat position.

2. TIG welds 16-gauge carbon steel plate with a B-5 butt joint in the flat position.

For TIG welding CRES, the training task is:

TIG welds 16-gauge CRES plate with a T-1 joint in a flat position.

For TIG welding monel the training task is:

TIG welds 16-gauge monel plate with a B-5 butt joint in a flat position.

For TIG welding bronze the training task is:

TIG welds 16-gauge brass plate with a B-5 butt joint in a flat position.

It is really these tasks that are the action elements of end-of-course objectives. These can be asterisked (*) on the Training Task Cards and in the Basic Curriculum Outline. These tasks do not appear in the Task Inventory so they cannot be identified there. To the degree that these tasks really represent the TIG application on-the-job, the course will be useful and valid.

Where do these training actions come from? They are chosen to represent all TIG plate welding tasks in the Navy by authorities on welding and disciplines related to it (metallurgy) and adopted by the Navy as

qualifying for the award of an NEC. The plates are specified in terms of size, thickness and other variables. In choosing them assumptions were made that if a thicker plate can be welded to standard, so can a thinner. On such a basis the above TIG plate welding tasks were chosen by the experts as representative of all TIG plate welding tasks, so far as application of the skill is concerned. They are not concerned with the problem of actual application under shipboard conditions. This of course requires a period of on-the-job transitional training.

For the design of both the CICWO course and the ET course, training exercises could be developed which evoked the right kind of responses from the students and provided the feedback which enables them to learn. Skill steps in the TIG welding process were easily enough identified. For most of them a training task is readily identified. Those that represent the essence of the skill, however, e.g., "TIG welds a pass using appropriate filler material" (4.1.11 in the Task Inventory), however, can be very difficult to develop a series of training tasks for. The problem is not in identifying what metals, what alloys, what electrodes are to be used, but in providing the means for the student to discover what muscle (kinesthetic) cues or what visual cues he must respond to. The basic problem is in identifying the cues the student should respond to and in providing the immediate feedback on correctness or incorrectness of what the student is doing in a way he can profit from it. For such perceptual-motor tasks, e.g., golfing, it is extremely difficult to do this. The welding case is further complicated by the ease with which feedback from visual and kinesthetic cues get confounded (Gibson, 1970). This is the reason for the need for professional assistance in designing training tasks for such skills. An example of a Job Task Card and its Training Task Card equivalent is given in Figure 6.

Job Task Card

4.1.7	Constructs mock-ups and assembles joints for TIG welding.

Training Task Card

Skill task number: 4.1.7

Training task: Identifies and assembles L-1 lap, T-1 tee, and B-5 butt joints for TIG welding.

Standard: Assembles each of the above joints with 100% accuracy.

Fig. 6. Job and Training Task Cards for TIG Welding Course

4. Adjusting to Course Constraints

Decisions concerning this problem are placed at this point in the course design process for two reasons: (1) One cannot estimate times until he sees the kind of training tasks that will be required; and (2) one does not wish to go to the trouble of constructing pilot exercises unless he is sure the training task will be included. Exercises that will be used require all the time the designer has available.

The course designer has before him a specification of the training tasks along with their qualitative performance standards, i.e., learning objectives needing only specification of more precise standards to be complete. With this first opportunity for a clear look at all that is involved in achieving the course mission, the question must be asked, Can training be accomplished within these constraints? Typically the answer is "No." The number of exercises that must be practiced are usually formidable when compared to the time allotted. Ideally the time constraints should be relaxed and the amount of time required to meet all the objectives provided. This approach will undoubtedly remain ideal. There are two alternatives. One is to change the who in the mission to require skill in more of the specific tasks at course entrance. This is usually not practical, leaving the alternative of reducing the length of the course by (1) eliminating some of the objectives, (2) reducing the standards to be attained, or (3) some combination of the two.

The first objectives to examine as candidates for elimination or reduction in standards are the first level tasks. Reducing standards of/ performance

required is a satisfactory solution provided that they are not reduced below the performance level. Reducing them to "knowledge about" terms results in the course becoming purely informational--the graduate undertaking his job with no skill in doing anything. All performance training is shifted to shipboard. It is the most complex or specialized Level I or II tasks which are the source of end-of-course objectives that should be first considered for elimination. Looking at the seven CICWO level I tasks, for example, it is clear that 5.0 and 6.0 are the more specialized and should be first considered for elimination. Task 1.0 as the most fundamental is clearly the last for which to reduce standards or to consider for elimination. In fact, were it eliminated, there seems no point in having a course at all.

If high level job tasks are eliminated, the enabling tasks for them, of course, may also be eliminated. Entire blocks of instruction can be eliminated. This is usually sufficient to bring the course within time constraints. If it does not, qualitative standards for retained end-of course objectives can be considered for reduction to a minimum performance level. If this is required, the lower level tasks can be inspected for reduction of standards. If these must be reduced to "knowledge about," the tasks are incorporated in the handouts and eliminated from further consideration.

The main course constraint problem with a course concerned with specific equipment maintenance is the proportion of course entrants who come equipped without the ability to perform the job tasks they are supposed to be able to do, e.g., operate test equipment. A high proportion of those who do not, can require an extension of course time or an undesirable lowering of standards.

Courses concerned with qualification to perform complex skills such as welding cannot logically eliminate an end-of-course objective. The only way to shorten such a course is by improving training methods and/or establishing higher selection standards, providing effective predictors can be found.

Either reducing standards or eliminating tasks does shift the line between shore and ship training; the less the school does, the more the ship must do. At least the way proposed here cope with time constraints guarantees the course graduate can perform the more fundamental tasks required by his duty. He does not enter on duty with nothing but information about it.

5. Determining Practicality of Exercises Specified

Complete construction of exercises should be deferred until learning objectives are complete. At this point in the design process the course designer will wish to satisfy himself that the manner in which he has specified the training task is practical to develop and manage in the school situation. Therefore, he should identify those about which he has doubt (these will be the more complex ones, most likely Level I) and develop a small pilot exercise. Necessary changes in exercise specification can be made. The complete exercise can be constructed later.

CONTENTS

CHAPTER VII

STEP 6. SPECIFYING THE TESTS

Tests, remember, are any systematic and standard way of judging performance. They are based on the training exercises and serve three purposes: (1) improving the course, (2) individualizing instruction and (3) evaluating student learning. The first two are by far the more important. Since the training tasks are as close to the job tasks as training conditions permit, both exercises and tests are job assignment oriented, i.e., this course design process makes certain that the exercises and tests are correctly oriented and developed.

1. Training Tests are Performance Tests

Training courses designed as described in this Manual, concentrate on getting the student to learn how to perform job tasks.

Tests for student or course evaluation purposes, therefore, are exclusively performance tests. In fact, the hallmark of a good training course is the large number of performance tests and the exercises on which they are based. Written tests for student or course evaluation are appropriate only if they validly

reflect the job actions. To direct compensatory radar actions to cope with atmospheric refractivity effects, for example, requires the plotting of radar holes from information in ANAPROP messages. This is a mental skill--the application of set of rules. Exercises and tests based upon them are written because the job task itself is written. To reemphasize, training tests are tests of ability to do something, not of knowledge for knowledge sake.

The something is either a job task "energize a radar," "repair a carbueurator," or the application of information or theory--a mental skill such as making a tactical decision, or locating a malfunction. The learning of an ET is not judged by a test of his knowledge of theory but of his ability to use it in doing a particular set of tasks. If Ohm's law can be reproduced and manipulated algebraically, but the student cannot locate a malfunction because he does not use the information in the equation properly, the theory is of little use. He may "know" it, but does not have the mental skill of applying it. Wherever such instances are found, training has failed. Tests must be developed to detect such failure. Testing knowledge as knowledge by means of written tests should be done only as an aid to the instructor in pacing his instruction.

2. Technical Testing Standards

With the exercise specified and what to score decided, the problem of test construction reduces to the construction of that part of the exercise that is to be used as the test. The kinds of errors or situations included, must represent or be a sample of, those the job incumbent will meet. This takes care of one technical standard for test construction. Others concern the usual ones of administration under standard conditions, reliability, validity, and difficulty of the test scores.

The parts of the exercise that are to be used for test purposes, therefore, are planned to sample well what has been practiced, and administered strictly in accordance with the directions or rules that have been established. This point is emphasized only because it is so easy to deviate, especially in the administration of complex exercises. Data from more than one exercise has gone down the drain because of failure to check out the procedures and training aids involved prior to each administration of the test.

Reliability of scoring does require checking for complex tasks, e.g., evaluating recommendations. The way to determine reliability here is to determine the consistency of scores of two equally informed job expert instructors, just as was done for the complex CICWO exercises.

There is much confusion on how to establish the validity of a training test. A test or test item is valid if it faithfully reflects the job task. The training task is derived from the job task and the training task is scored as a test. The course design procedure itself therefore guarantees the validity of the test. It also makes plain why difficulty is not a technical problem.

These matters are not understood because of a failure to distinguish between training tests and aptitude tests. This failure has seriously hampered the improvement of Navy training. The distinction is basic. Tests used to measure student learning are altogether different from

aptitude tests. Aptitude tests are aimed at predicting future performance; training tests, for determining present performance. Aptitude tests are designed to spread people out, to detect differences; training tests, to discover whether students have become more alike in the sense of being able to perform a job task to a specific standard. Whether some do better than this is of no concern from a training point of view. Items in aptitude tests must not only be related to future performance but be of particular difficulty levels, discriminate among persons, as well as having other technically desirable characteristics; items of training performance tests need to have but one characteristic--be a faithful or valid reflection of the task that is being trained. In particular, the level of difficulty of an item has nothing--repeat nothing--to do with its value in a training performance test. If all students succeed, or all fail, in an aptitude test item, it is worthless for prediction purposes; if all students succeed, or all fail, on a valid training performance item, it means in the first instance the instructors have done a good job, and in the second that something is wrong about the training program. This means that instructors should never--repeat never--use techniques of item analysis developed for aptitude tests with training tests. If one throws out test items of a valid training test that are easy (a high proportion pass) or the hard ones (a low proportion pass), he is throwing away the items of particular importance to him as an instructor. If he keeps only items which discriminate high from low scores on the entire test, he may wind up with a test that discriminates and even may be predictive of some future performance but it will no longer reflect the attainment

of the learning objectives. It will be an aptitude test, not a training test. To put this another way, failure on a properly designed training test indicates the instructor has a training not a testing problem. At the present time Navy testing of training performance could be substantially improved by abolishing item analysis procedures altogether so far as training tests for specific courses are concerned. To repeat again, the only thing of concern about a training item is its faithfulness in reflecting the job task. This faithful reflection is an automatic outcome of the application of the course design procedure described in this Manual.

It must never be forgotten that tests are designed to discover whether students have met the objectives. The more that do, i.e., the more that get the same score, the happier the instructor should be. It means he has done a good training job. Now it can be understood why training tests, rightly understood, make the student and the teacher partners in a learning enterprise, something the reporting in relative, aptitude score-like terms, cannot accomplish.

3. The Number of Tests

Ideally the number of tests should equal the number of training tasks. Practically, it is impossible to reach this ideal with formal tests. Training courses are to train, not test. Time between the training and testing must be allocated with judgment. One can, of course, frequently estimate student performance by observation, shrewd questioning, etc. But decisions do have to be made concerning which training tasks will be thoroughly tested. Without exception, achievement of end-of-course objectives must be tested. The possibility of continuous course improvement vanishes unless this is done.

Should it be necessary to reduce testing time because of course constraints, the performance on the least significant of the chosen enabling objectives can be estimated by discussion with students individually or in the classroom, through observation, and so on. But learning to estimate CPA on the radarscope is so important to the accomplishment of the CICWO's situation assessment, and recommendation that tests are warranted. Knowing the location of the Captain's log in the CIC, while essential, on the other hand, would not require a special test: Choice among enabling objectives to test thoroughly should be made in terms of criticality of the action element, in terms of its importance for particular course improvement purposes, and in terms of the ease of estimating information about student learning in a less formal manner.

By identifying only significant enabling training tasks for inclusion in learning objectives (Step 2), a large stride has been taken toward solving the test number problem. The fact that testing is part of a training exercise also reduces testing time, thus contributing to the same end.

4. Constructing the Performance Tests

What should go into tests is directly stated or implied in the training tasks. The test for the CICWO training task, "Discriminates between good and bad radarscope presentations," becomes a series of representative tasks representing the kind of misadjustments that can occur, a few of which are illustrated below:

(1) The focus control misadjusted by 90° or more from an optimum setting (as selected by instructors).

(2) The intensity control misadjusted by 90° or more from an optimum setting (as selected by instructors).

(3) The video gain control misadjusted by 180° or more from an optimum setting (as selected by instructors).

(4) The range scale set at 50 miles when the function of the repeater is normal surface search; or with the range scale set at five miles when the function of the repeater is long-range surface search.

(5) The STC control ON in sea-state conditions of zero to one; or with the STC control OFF in sea-state conditions of four to five.

(6) The radar repeater in relative bearing when true bearing is required; or vice versa.

(7) The function selector set for an inappropriate input for the use specified for the repeater, e.g., air-search radar presentation on surface search repeater.

The test score is readily seen to be the number of errors or correct responses.

For testing purposes the emphasis should frequently be on tasks that well nigh perfect performance is expected--a minimum essentials concept. The reason for this approach will become clear in the next chapter.

Most of the work basic to test construction has been accomplished in the specification of the training tasks (Step 5). The specification included suggested scores for the complex exercises. If the job task and skill analyses and their translation to training tasks have been well done, test development

is, for most tasks, easy. In tasks such as, "Detects from an equipment status board in the mock-up all inoperative or malfunctioning CIC equipment," "Selects the correct (of four) soldering irons for use on printed circuits," "Start the AN/SPA-34 indicator," "Select the correct flux to be used in TIG welding carbon steel," what should be sampled and scored presents little problem. The student's errors or correct responses can be counted. A good question to ask one's self if he is in doubt about what to score is: what is the purpose of performing the task? How should one score the basic ET task, "Connecting a copper wire to a lug?" Obviously the purpose of the soldering is to permit conduction of current over a considerable period of time. The essential tests, therefore, are the determination of whether the connection does in fact conduct current and is strong enough to hold. The former can be objectively tested. The latter can be tested by pulling. Experienced instructors will have a good notion of how strong a pull should be used. The strength will probably vary with the criticality of the circuit and the difficulty of getting at the points to be connected. Scoring is plus or minus, therefore, in terms of a conductivity and a pull test.

a. Scoring CICWO exercises. Scoring most of the exercises for this course presented no difficulty. The student takes the right action or he does not, e.g., he either discriminates between messages that should be sent by swift memo or he does not; he recommends the correct whistle signal in a Rules of the Road situation or he does not; he recognizes that tactics of surface contacts are hostile or he does not; he detects an incorrectly estimated plot or a man overboard or he does not. Likewise the student either detects an error designed into the training task for Job Task 1.0, or he does not. The number of errors detected, or assessed, is the score. Scoring recommendations right or wrong takes a little more effort. Two experienced instructors are asked to independently score the recommendations given by the students in the exercise and the consistency of their responses determined. The exercise for Task 1.0 was so investigated and sufficient consistency found to warrant the use of the recommendation score (Riley & McCutcheon, 1970).

b. Scoring equipment maintenance courses. For training to maintain equipment there is even less problem in determining how to test once the training exercises have been specified. Tests are simply a sample of the exercises covering the diagnoses to be made, parts of which are given and scored in a standard fashion.

c. Scoring welding training tasks. Scoring a welding training task is a more difficult problem than scoring either a CICWO or ET task. Fortunately, methods (nondestructive testing) have been developed by experts and special NECs established to train the testers. Hence, scoring of end-of-course tasks is not the instructor's responsibility. He must, however, score the lower level tasks. Tasks such as 4.1.2, "Identifies, assembles, and energizes TIG inert gases and equipment," 4.1.7, "Constructs mock-ups and assembles joints for TIG welding," 4.1.8, "Prepares surfaces to be welded," and 4.1.5, "Uses and interprets TIG welding reference manuals," lead to straightforward methods of testing and scoring.

5. Instructional Purposes of Tests

In addition to serving their course and student evaluation purposes, tests have the valuable instructional purpose of providing the basis for individualizing instruction. They do this in two ways. First by their use as pretests to determine where each student should begin his learning when he enters the course or a particular section thereof. This purpose is extremely important to the efficiency of the course. Eighty percent of one CICWO class were able to pass the final examination in solving maneuvering board problems (Meyer, 1969) when they entered the course. Many students have since omitted this part of the course as a result of the use of pretest (a savings of 40 hours per student in terms of the way the course was organized at the time this pretesting started) and hence had no need to spend time on this topic. Pretests can frequently be the final examination or alternate form of it, arranged in a manner that the occurrence of failure shows where the student must begin his learning. The other aspect of individualization involves pacing the instruction so that each student is learning at his own rate. Apart from self-pacing by use of PI, something that is not always possible or desirable, the instructor will want to know which students are ready to go on, which are not. Sometimes he is concerned with the entire class when the next topic he will discuss or the next training task he will have the students learn requires extensive preknowledge of procedures, vocabulary, or something of the sort. The best way for the instructor to find these things out is through guiding and observing student discussion or his approach to the operation of certain equipment or whatever the training task may be. If he cannot estimate by such informal methods and the training exercises

do require thorough knowledge, say, of vocabulary, he may wish to give a more formal test. He may wish to construct a pencil and paper test of the vocabulary required. This illustrates the one situation in a training course where a "knowledge test" is useful. Such tests should never enter into evaluation purposes--either of the course or of the student. Tests for instructional pacing purposes need not be thought about until the development of lesson plans. The existence of knowledge tests in any number is an almost certain indication the course has veered in the direction of becoming a knowledge or "knowledge about" course, i.e., it can no longer be an effective training course.

6. Tests and the Transfer Problem.

Because of the relationship of higher and lower level tasks, and because training tests are based on job actions, as nearly as they can be duplicated in the classroom, the instructor can frequently get an idea of how well what

the student learns will transfer to shipboard performance. The exercise for training task for CICWO task 1.0, "Serves as a CICWO on a combatant ship during normal steaming conditions," (Training Task 26) requires the CICWO to monitor information, process, evaluate the tactical situation and make recommendations. To do so requires doing the lower level tasks

in the Inventory, e.g., he must monitor all the operators and displays. Most of these lower level tasks are too complex to be learned simultaneously. Hence, many must be learned separately before being practiced when integrated into the larger training task. By getting a measure of the lower level tasks, when trained separately and when practiced in combination with the other tasks, the instructor can tell whether his training is transferring from the one learning situation to the more complex learning situation. If a computer-based simulation is available, the higher level training tasks can be conducted in real time and transfer from classroom to more realistic conditions measured. Such a procedure is most valuable and should be used whenever possible. It is one of the best means of achieving fundamental improvement in the course. If students do well when attending to one task alone but poorly when they have to integrate it with others, either more practice in integration is needed or methods of training the task independently need improvement. For example, if the student can apply rules of the road when working special problems involving just these, but fails to use this information when a situation requiring application of these rules is met in the course of a complex exercise, something is wrong with the method of instruction for the "rules of the road" unit. If the student can solve troubleshooting problems on paper but not when faced with the equipment, training has likewise failed.

TABLE OF CONTENTS

CHAPTER VIII

STEP 7. COMPLETING THE OBJECTIVES

This step requires putting standards for each learning objective in terms of the tests specified in Step 6, a final editing of the objectives, and specifying standards for graduation from the course. This last is not accomplished by adding up the standards for end-of-course learning objectives, nor does it have to be a matter of constructing a special test.

Ultimately setting standards boils down to a matter of instructor judgment. The only exceptions are when standards are set by some authority for some qualification purpose (NEC, advancement in rate) or when they have been established experimentally by follow-up studies of success of course graduates on-the-job. Such studies are fully as difficult and time-consuming for training tests as they are for aptitude tests. Follow-up studies to establish the validity of end-of-course tests may sometimes be justified, but generally speaking, if tests are based on training tasks which are essentially the same as job tasks the validity of the course content is assured. Trying to uniformly set standards for training tests on the basis of follow-up studies is totally impractical. By the time the cutting scores on the tests have been established, the requirements of the course may have changed, better training exercises, which serve as the basis for the tests, will have been invented, and one must start all over again. Fixing training tests long enough to do the studies is not desirable. It fixes too much because of the close relationship between what is trained and how its attainment is measured. So one is forced to rely on the judgment of

the job experienced instructor checked by a job survey in some instances--a judgment based on scores from well constructed performance tests for all end-of-course objectives, and some proportion of the enabling.

Standards for the objectives, the training tasks of which are selected for thorough testing cannot always or even usually, be set in advance of trying the test in the course. They become possible only after the tests have been developed and used. During the developmental period, the instructor has less to guide him in making the judgment he must make. When quantitative estimates cannot be made during initial design of the course, standards can be expressed in the qualitative terms of the rating scale (percentage estimates are another way of expressing qualitative standards) used in Step 3.

1. Standards for Specific Learning Objectives

Standards for specific learning objectives are best established in terms of go/no-go. The nature of many of the tasks in an Inventory lend themselves to such a standard. One can either "solve CPA of a surface contact from a radarscope plotting head" or he cannot; he can, or he cannot, "detect and correct procedural, reporting format, and security errors made on a classroom presented audio-tape of a hypothetical CIC radiotelephone net"; he can or he cannot "discriminate between good and bad radarscope presentations, given a series of slides in the classroom showing various radar repeater displays." The student can use electronic test equipment or he cannot; he can or cannot "isolate a malfunction within a function of the AN/SPA-34, locating test points and components, following safety precautions, using logical troubleshooting procedures, the schematic diagrams, and appropriate test equipment."

Many of the enabling training tasks in the TIG welding course also readily lend themselves to a go/no-go standard, e.g., "tack weld each of above joints with no visible rejectable defects." Job experts know what is involved in these and they concern sufficiently standard defects that no problem is encountered. Visual standards for rejection of a weld concern fusion, cracks, arc strikes areas in the neighborhood of the weld, etc. A check on the consistency with which these judgments are made is good procedure.

This go/no-go approach gives the reason for applying the minimum essentials concept of testing to training courses. Items or trials in a test should be selected to represent the absolutely critical ones, ones on which perfect performance (with minor allowance for special conditions) are necessary. Training tasks, of course, can and should include more difficult material.

The nature of electronics maintenance job tasks lends itself to an interesting kind of standard--100% accuracy before letting the student go any further. If a student, for example, cannot locate a malfunction to a functional block, there is no point in letting him continue within the block.

Because training exercises for setting up, operating, maintaining, and using test equipment are especially critical, they are first used as a test of the student's skill in these respects. If he does not do well, remedial training and further practice are given before permitting the student to continue. If an ET cannot use test equipment to discriminate normal from abnormal wave forms, voltage, current, and resistance outputs of equipment, further training in correcting malfunctions is useless until he can. Use of such standards requires course scheduling to permit individualization of the instruction.

With the tests established and standards (tentative in most cases) established the learning objectives are complete. These can be edited for final wording. In editing stress should be placed on increasing the communication power of the objectives to instructors, to training management, and to consumers. An objective is supposed to control course content. Unless it is consistently interpreted by all instructors, it will fail in this purpose. Course standardization likewise becomes impossible.

This view stresses that student evaluation should be in terms of ability to perform or not perform the job tasks for which he has been trained. How much more or how much less is of no interest from a strictly training point of view. Printing action element objectives in abbreviated form, in small type usually permits getting them on two sides of a single sheet. Checks can be made by those tasks for students who did not achieve the standard; no check indicating satisfactory performance. The qualification performance scale can be included and coded so each task carries its code number. Such a report would be a highly meaningful form of communication.

The final step here is to add the standards to the Training Task Cards.

2. Standards for Course Graduation

As noted in the overview in Chapter I, it is the tasks critical to life, equipment, and the ship itself that are of concern in setting standards for graduation. They can be geared to go/no-go standards on the critical job tasks. Either the student can do the highly critical tasks or he cannot. What a go/no-go standard means in terms of success or failure in the course is that such factors as the critical nature of the tasks

for operations (risk to life or equipment), the likelihood of the requirement of the course graduate to perform the task without supervision before he has received on-the-job training, the likelihood he can learn the task on the job and the like. A CICWO who has not learned to assist in bringing a ship into a harbor in a fog, who does not recognize immediately the recommendation to be given to keep his ship in proper formation, or who has not mastered the tasks involved in a "man overboard" is hardly to be trusted alone regardless of how well he did on other training tasks. An ET who cannot use test equipment cannot keep the radar in operation. Any one or a combination of such reasons should lead to retention of the student in school training until he can meet standards on even one failed task, if it be sufficiently critical. Any other course has grave disadvantages for both the ship and for the student's naval career.

TABLE OF CONTENTS

TABLE

FIGURES

CHAPTER IX

STEP 8. ORGANIZING AND SCHEDULING THE COURSE

This step sequences the general order in which objectives will be attained, makes provision for introductory and review sessions, and schedules the course in a manner to achieve the flexibility required to adapt to individual differences. It results in the Basic Curriculum Outline.

1. Specifying Introductory Units

This is a matter of establishing learning sets[17]--the attitude which keeps what is learned in the context for which it is to be used. There are a great variety of purposes for which any mental or physical skill is to be learned. EW tactics are learned by the EW officer for one purpose or set of purposes; by the CO of a destroyer for another; by the CO of a CVA, another; by the CO of a flotilla for still another. Electronic theory can, also, be learned for a variety of purposes. Operating a radar can be learned for the purpose of operating it or maintaining it.

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[17] The concept is quite different from the one that has introductory units concerned with "tool" or "basic" subject units as discussed in the first edition of this Manual. A deeper insight has shown this is not the real need and has the disadvantage of diverting one back into a knowledge orientation. The problem was that we had not discovered how the Task Inventory should be organized. When the essentially simple idea of starting the Task Inventory with the simplest situation, i.e., "normal steaming," occurred to us, the problem of "tool" subjects disappeared. This is because under normal steaming all basic tasks were identified and later more complex situations encompassed these basic tasks as well as others. No adjustment was necessary. Duties involving technical mental skills were already at the beginning of the Task Inventory so the Task Inventory order was roughly appropriate for curriculum outline purposes. All basic mental and physical skills were completely stated and incorporated at appropriate points with the completion of Step 5.

How the student understands the nature of the duty assignment for which he is being trained will markedly influence both what and how he learns. It is of utmost importance to establish the learning set appropriate to the particular job assignment. This consists of starting the course and each section of it, in a manner which makes clear just what tasks the student will perform on-the-job, just how he will use the skills he is going to acquire. The set to learn what is appropriate for the particular duty assignment means that the "job essence" must be made clear. What is it that distinguishes this duty assignment from those above, below, and at the same level in the job hierarchy? A good way to answer this question for the students is to present real examples from the complex end-of-course test exercises which represent the end-of-course tasks and get the students to actively participate to the extent their experience permits. The instructor makes clear what the problems are, to what kinds of cues the job incumbent must respond and the alterante responses that are possible. A learning set appropriate to the use of the skills taught in each section of the course should, also, be incorporated in the separate introductory units. All such subordinate learning sets should be compatible with the learning set established for the course as a whole, i.e., each skill should be learned in the context of the higher level tasks in the Inventory. Supplementing the learning sets by giving the students the objectives to be achieved should leave little doubt about what they are expected to learn for what purpose.

In the CICWO course, an introductory unit to provide a learning set for the entire course is being developed. It is being done by presenting a taped version of the Monitoring I exercise during the first day of the course. (This session is labeled "Concepts of CIC" in Figure 7a.)

Block I

Second Week
Tuesday 0800-1140

Introduction To Course (lecture)

√Concepts of CIC (Learning set) (lecture) (following set)

√Techniques of Radarscope Maneuvering (demo)

√CIC Publications (demo)

Diagnostic Pre-tests

√Radiotelephone (PI)*

√Maneuvering Board (PI)*

√ATP 1(A), Vol. II (PI)

√External Comm (PI)*

√Comm. Status Boards (PI)

√Internal Comm (PI)

√DRT (Ind. Inst.)

√Rules of the Road (PI)*

√Surf. Tracking H/U (Ind. Inst.)

√Communications (classroom exercise)

√Form. Diagram + Surf. Sum. Plot (lecture)*

√General Radar Familiarization (PI)

* Learning set included in Program

Day's Work in CIC

Review as needed

Monitoring CIC Personnel (I)

Shipboard Task-1.0
Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently.

Monitoring CIC Personnel (I) Test

Block II

Second Week
Friday 0800-1100

✓Line Formations (I)*

✓Single Line Formations (M/M)

✓Monitoring Surface Radar (Ind. Inst.)*

✓DRT For Man Overboard (Ind. Inst.)

✓CIC Response to Man Overboard (PI)*

Shipboard Response to Man Overboard (PI)

✓SAR Communications (Reading)

✓SAR Organization (Reading)

Circular Formations (PI)*

✓Surface Screens (PI)*

✓Evasive Maneuvers (PI)*

✓Nuclear War Comm. Requirements (Reading + Ind. Inst.)

*Learning Set included in program.

Day's work in CIC

Block II Pre-test for diagnostic eval. of Students

Review of CIC Concepts

Review as needed

✓Monitoring CIC Personnel (II)

Shipboard Task - 2.0

Serves as a CICWO in a CIC involved in supporting a ship maneuvering in formations and Screens.

Fig. 7b. CICWO Block Schedule

Block III

Third Week
Tuesday 1400-1545

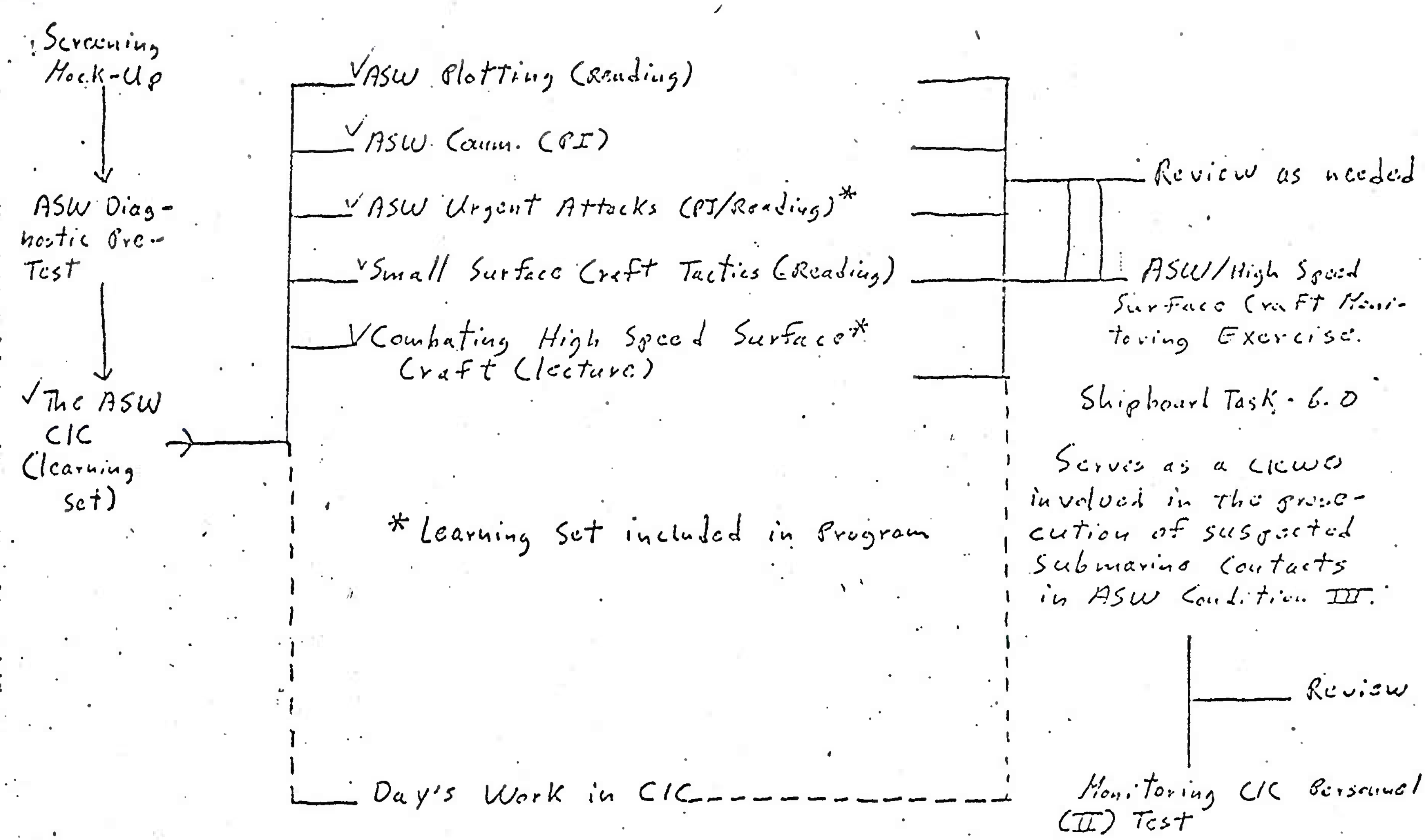

Fig. 7c. CICWO Block Schedule

Block IV

Fourth Week
Wed. 0800-1140

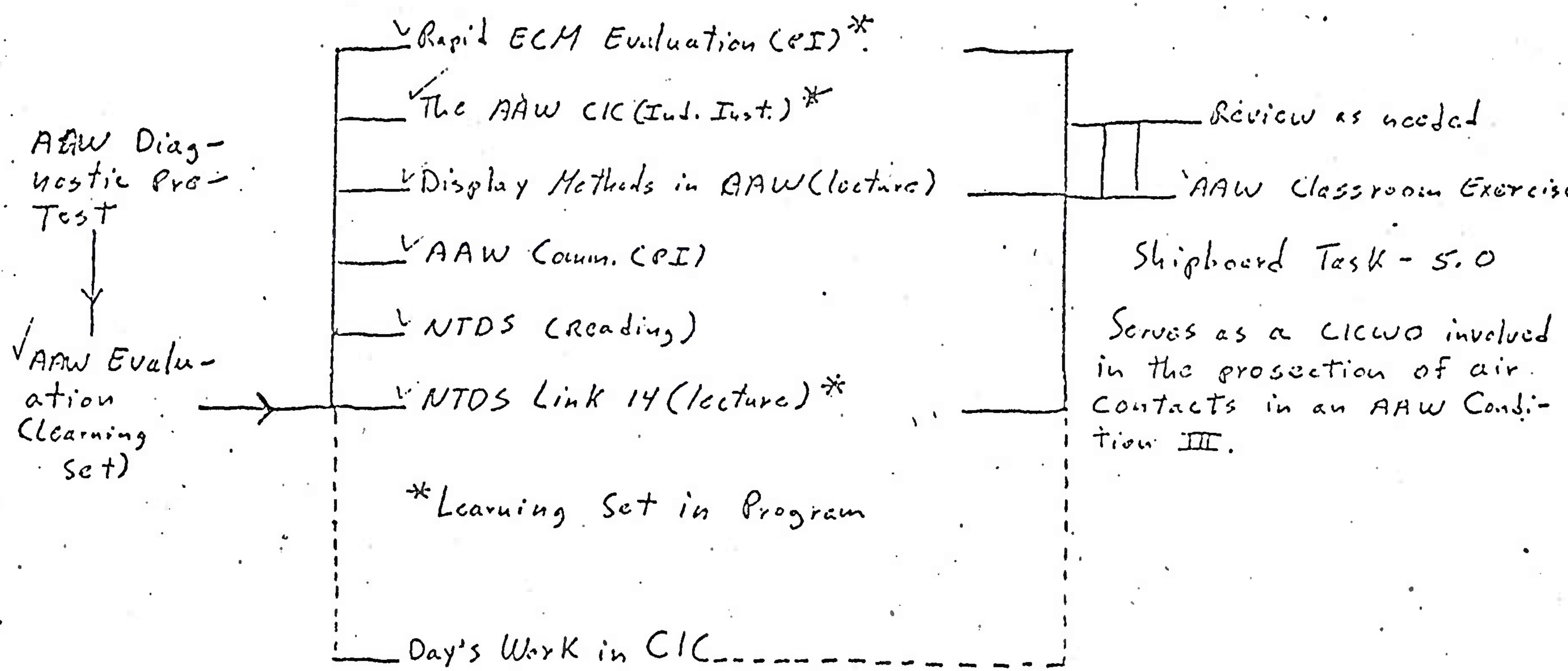

Fig. 7d. CICWO Block Schedule

Block V

Current
Fleet Problems
(Briefing lecture)

Fourth Week
Thursday 0800-1145

Review as needed

Monitoring CIC Personnel
(III)

Shipboard Tasks: 3.0 & 4.0

Serves as a CICWO in a
CIC participating in a man
overboard recovery.
and
Serves as a CICWO in a
CIC participating in a Search
and Rescue (SAR) mission.

Review

Fourth Week
Thursday 1300-1545

Day's work in
CIC -- Final Project

Shipboard Task-7.0
Relieve The Watch

Review

Monitoring CIC Personnel
(III) Test

Review of Course and
Check-out.

Fig. 7e. CICWO Block Schedule

The student can hear the CICWO correcting errors and making recommendations. This demonstration shows what the tasks learned in the course will be used for. Each enabling learning objective will be learned in the context of the end-of-course objectives it supports. This in effect provides the learning set for the lower level objectives. In an electronic maintenance course this method appears an excellent way to keep subordinate tasks that must be learned in the context of the higher level job tasks. The introductory unit for the course as a whole should place the AN/SPA-34 in the context of radar repeaters generally, should provide an overview of its fundamental units and how they differ from other radars in function and in the circuitry required. Job Task 7.1, "Briefs operators on basic characteristics and accuracy of AN/SPA-34 repeater," fits in well with such a "learning set" introductory unit.

As currently planned, in a welding course the major introductory unit will identify typical welding tasks and relate them to the skills the trainee will acquire during the course. It will demonstrate in slow motion film what happens during a welding pass. It will include the equipment system parameters that must be taken into account, e.g., implications for safety precautions or other procedures.

2. Sequencing the Learning Objectives

Sequencing the learning objectives is accomplished in terms of the logic of what is being trained and in terms of learning principles. The logic of the course content is the first consideration. Enabling objectives obviously must be learned before end-of-course. One cannot integrate relatively specific tasks into complex tasks unless the former have been learned, i.e., the order is just the reverse of that in which

the job tasks were identified. Likewise learning of some training tasks should precede others; an EWO cannot very well apply the necessary electronics concepts until he has learned them and, more important, how to apply them. Remedial objectives like other enabling objectives, should immediately precede the higher level objectives for which they are pertinent. The temptation to put <u>all</u> remedial sections as well as so-called "Fundamentals" at the beginning of the course should be avoided.

Most of the time, the logical sequence is clear to the job experts. Sometimes the sequence is immaterial. It probably makes no difference whether a beginning ET learns to solder with an particular iron before or after he learns about the variety of irons that exist for other purposes or whether a CICWO learns "man overboard" procedures before he learns how to use the signal book.

The sequencing is accomplished by sorting the Training Task Cards until the instructor is satisfied he has them in a good logical order. He then inspects the order for consistency with the learning principles in Table 2. Principle 1 will be taken care of by insertion of introductory units, Principle 4 by providing for review sessions; Principle 10 by providing the organizational flexibility; Principle 2 by the nature of the course design process; Principle 7 in the construction or practice exercises. The remainder of the principles in Table 2, with the exception of 5, apply to lesson planning. Principle 5 involves the avoidance of instruction in tasks highly similar to one another too close together, e.g., two welding processes which require similar pass movements.

TABLE 2

Learning Principles

1. Instruction should relate end-of-course and subordinate tasks taught to their use in the job situation.

2. Instructional method should be consistent with the nature of the objectives.

3. A context or framework should be <u>taught</u> for the student to use in organizing what he is to learn, i.e., a learning set should be established in terms of the context.

4. Spaced practice and review promote learning.

5. Teaching highly similar tasks or materials in too close proximity (one too soon after the other) interferes with learning.

6. Variety in the day's instruction maintains motivation and helps overcome monotony and fatigue.

7. A variety of practice materials should be provided.

8. The student should be told what he is supposed to learn.

9. The student should be given knowledge of his progress and his errors.

10. Instruction should be so arranged as to permit adaptation to individual differences in student aptitude and experience.

11. Instruction should be paced by the students' learning rates.

With the Training Task Cards in the order desired for instructional purposes, it is convenient to number the training tasks consecutively for ease in referring to them. The Training Task Cards are then sorted to pair with their associated Job Task Cards. The numbering is illustrated in the Basic Curriculum Outline (Appendices B, D, and F). Before this is typed, introductory and review units should be inserted. "Knowledge about" tasks, identified in Step 3 are added as the last section to remind the instructor to prepare the necessary handouts. The CICWO course design was the only one of the three courses we have been dealing with that had a number of these. They can be inspected at the end of the CICWO Basic Curriculum Outline (Appendix B).

3. Specifying Review Units

There is a learning principle to the effect that spaced practice generally improves learning and retention. As the objectives are arranged in the Basic Curriculum Outline they concern the introduction and major part of the training to meet them. Final standards may not be met until after further practice, distributed through the course. When needed, such practice requirements should be inserted in the outline. The arrangement of the Task Inventory helps solve this problem because the initial broad tasks involve smaller tasks which will be repeated later. When broad tasks do not involve the same lower level tasks, review sessions will need to be specified. Most of the time it will be found that the course design procedure results in inclusion of a sufficient number of review units.

Tasks that must be performed correctly the first time aboard ship, e.g., critical safety precautions, must be overlearned. These should be distributed through the course to provide the amount of practice needed.

For the CICWO course it was found that review sessions occurred automatically because of the sequence of the Level I tasks. As the student proceeds from the instruction concerning independent steaming to that concerning maneuvering in formation, there is automatic review of fundamental tasks required as well as of the basic concepts concerning DRT, maneuvering board, displays, etc. This is, also, the case as the student goes on to the other end-of-course objectives. There is, also, review involved as one progresses from learning enabling tasks to end-of-course tasks.

Review units are, also, automatic for ET tasks because of their repetitive nature, i.e., reference to the Technical Manual, use of test equipment, repairing, and documentation occur under many maintenance tasks and especially under location of malfunctions. Likewise, the TIG plate welding skill is practiced over and over again with each metal. Hence, review of the basic process is again automatic.

Finally, the order of the Training Task Cards is inspected for sequence in terms of learning principles. The Basic Curriculum Outline is then typed. This document becomes the guide for the instructor in developing his lesson plans and conducting the instruction.

4. Scheduling for Adaptation to Individual Differences

There are two kinds of differences to consider--those characteristic of the student and those characteristic of the duty assignment. There should be little problem in making provision for the latter if the duty assignment locations specified in the mission do not involve too many different job

tasks. The adaptation consists of scheduling common tasks first; differences are adapted to later by providing different learning situations for those having different ship type assignments. The only problem that will arise is when differences in ship type require greater adaptation than can be made in a single, time-constrained course. In such an instance it is the training program, i.e., a series of courses, perhaps interspersed with shipboard assignments, that must be adjusted.

The really fundamental problem here is the development of a flexible schedule so that students are not required to participate in sessions which present what they already know how to do or which forces them to pace their learning to a fixed schedule. In short, the schedule should not be in lock-step terms requiring all students to do the same things at the same time. The evidence is quite clear that Navy training courses can be improved enormously in efficiency by organizing them in a manner permitting adaptation to individual differences. There are two kinds of student individual differences to consider--differences in the experience students bring to the course and in their rates of learning.

Such flexible scheduling also puts emphasis on independent learning by the students. Career Navy men are, after all, adults and have developed their own ways of learning. If they are guided toward what they should learn and their progress checked, they can learn a great deal on their own. To achieve the flexibility of organization needed to adapt to individual differences, the schedule is arranged in blocks rather than in days and hours.

Use of PI is a favorite but often inappropriate means of permitting the individual to proceed at his own pace. If students are locked into a fixed schedule the main advantages of PI are lost. Instructors are not freed for other instructional purposes; nor is student time saved. Since it is a common finding that PI does not bring about greater attainment of objectives but the same achievement in a shorter time, there is not much point to having it unless the student can go on to something else when he completes the program.

Adaptation to differences in rates of learning is of particular importance in learning complex skills such as welding, sonar target classification, or ET maintenance. The early phases of such learning are basic to further progress. If a student quickly learns the cues and responses to complete a good welding pass, he should be able to go on. If he does not, he should be helped to so learn before being permitted to. To discover what the student's progress is during the early phase of learning this welding skill, one must rely on close observation, possible only when the course is individualized. Evidence is being accumulated that by arranging for such observation and adapting to the individual differences in rates of learning, brings about a substantial gain in the efficiency and effectiveness of the welding course (Carr & Abrams, 1970; Gibson & Abrams, 1970). In courses that do not involve initial learning of complex physical skills, it appears that differences in experience are the more important kind of individual differences to adapt to (Meyer, 1969).

Adapting to student individual differences requires a program for finding out what they are. To discover differences in experience, pretests should be given at the beginning of each major unit of instruction, including the one at the beginning of the course. This pretesting identifies those who are to enter the remedial sections of the course.

The major requirement in flexible scheduling is block scheduling. This means that instead of planning the instructional day in terms of an hour by hour lock-step schedule, planning should be in terms of blocks for topics or major objectives, e.g., end-of-course or difficult enabling ones. The only times specified are those for the block as a whole and, within the block, times when all students will come together for practicing a classroom exercise or tests at introductory sessions. How is such a schedule to be expressed? It will take a little trial and error for each type course. An ideal schedule for learning system specific duty assignments is to have all students together for the establishment of learning sets and for diagnosis of where they are in a learning situation. On the basis of the diagnosis students can be fanned out, some for PI, some for independent study, some for special discussion groups, all working around a supervised study homeroom as a base.

For the watch officer course a block schedule for major units of the course has been worked out and recommended. It is given in Figures 7a to 7e. The asterisked items refer to introductory sessions.

An ET "C" course would appear to be ideal from the standpoint of adapting to individual differences. Entire class sessions should be few. The emphasis should be placed on achieving the flexibility required to adapt instruction to what the student can do as he starts an instructional unit and how rapidly he can learn from that point. Accomplishing this is relatively simple for a laboratory course. With pretests (performance tests for use of test equipment, for example) showing the instructor where he needs to begin with each student, scheduling can be readily arranged in terms of discussion groups, study groups, special practice in certain equipment tasks, in use of the Technical Manual, and in learning to document properly. This concept is illustrated in Figure 8, developed by ETC C. A. Miess.

Students who complete a unit should be permitted to go on to the next. If a student reaches the end of the course early, he can be given a series of more complex malfunction problems involving more difficult interrelationships to disentangle.

Organizing the course to fully adapt to individual differences will of course markedly reduce entire class sessions. Use of the

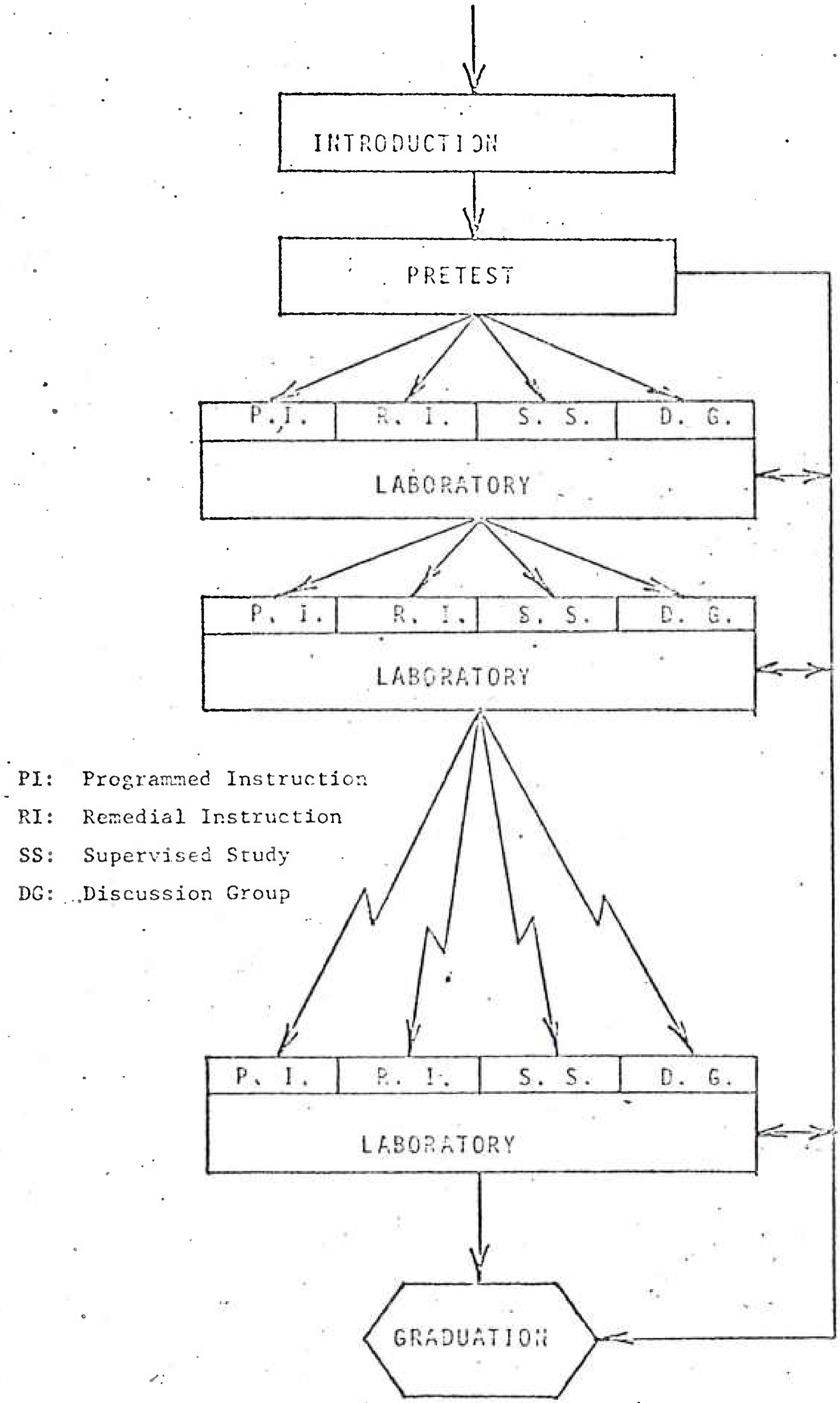

Fig. 8. Individualizing a Laboratory Course.

Technical Manual schematics as a basis for group discussion of the procedure is a good instructional technique for this kind of subject matter. Such a technique should be used with selected discussion groups where students share a common difficulty. Instructors should always keep in mind that understanding is best demonstrated in actual task performance. Discussion organized around the location of malfunctions within a particular functional block is helpful but should be continued no longer than necessary for the student to begin practice on real or simulated equipment in a manner indicating he has made a start in the acquisition of the mental skills involved.

Welding is an even more clear example of a skill, the learning of which should be individualized. In a welding course lectures should practically vanish, being replaced by discussion or a kind of operational (as opposed to sheer knowledge) PI, and discussion with individuals of their problems. A block schedule is planned but only across large instructional units. Within each welding process the student will be able to proceed at his own rate. If time remains at the end of the unit, the student is given more end-of-course tasks to practice to bring his skill to a higher level. Such a schedule is not meaningfully illustrated in its entirety. Each day's (week's) schedule looks like the one below. Nothing will differ but the training task to be practiced. Programmed instruction on relevant matters is planned to provide variety in the day's work. It is hoped that classroom lectures will be almost completely eliminated. Each day's schedule will look something like this:

Period	One Day's Schedule
1st	Each trainee identifies, assembles, energizes TIG welding equipment. Includes striking and maintaining arc while welding individual and tie in passes.
2nd	Closely supervised practice on above and add performance of routine maintenance on TIG equipment as trainee demonstrates proficiency.
3rd	Classroom programmed instruction in welding procedures.
4th	As trainee demonstrates readiness to go on, provide individual demonstrations/closely supervised practice in TIG welding a tee joint in 16-gauge CRES plates with a B-5 butt joint in the flat position.
5th	Same as period 4.
6th	Same as Period 4.

Such a schedule should permit a student to proceed at his own pace and allow the instructor to manage each student's learning problems. Clearly the instructional planning for a large block unit becomes a matter of cooperative effort by all.

There appears to be more bafflement regarding one aspect of the flexibility problem than there need be. The question, "What can be done with individuals who finish PI ahead of others or who already have the skills to be trained in a particular section of the course?" occurs frequently. They can be used to help slower students. They can be given special assignments. They can proceed to their job assignment. It takes administrative thought and supervision but not nearly as much as is usually believed. If administrative problems are to control training, ineffective courses and excessive costs can be expected.

TABLE OF CONTENTS

CHAPTER X

STEP 9. DEVELOPING AND CONDUCTING LESSON PLANS

The individualized approach just described, a full application of which can save untold dollars, can be successfully managed only by well prepared and well trained instructors. For example, when a training exercise is administered, the instructor must be prepared to answer student questions and discuss the pros and cons of the responses made. He must be a real job expert. He must have some skill in inferring student's learning problems from their responses. Otherwise he cannot manage their learning processes. Poor student achievement should call the attention of the chief instructor to the possibility that an instructor is unable to do these things.

1. Developing Lesson Plans

The Navy instructor knows the developing part of this step as "lesson planning." Organizing a course in blocks to permit adaptation to individual differences makes a tremendous difference in this planning. There is required the completion of exercises and tests specified in the Basic Curriculum Outline and the development of a plan for the entire block. The first step in planning is obviously to outline the sessions which the entire group will attend for establishment of the appropriate learning sets and for practicing and testing training actions for diagnostic purposes. The rest is a matter of preparing for the kind and number of individualized sessions that are anticipated. This is a far cry from the usual lecture preparation and informal preparation for the conduct of laboratory or mock-up sessions. Standard formats for lesson plans become inappropriate for everything except the occasional lecture. Because of their long

experience with typical lesson plans, some instructors find it difficult to go from the objectives in the Basic Curriculum Outline to preparation of the lesson plans of the kind required by this course design process. It is suggested, therefore, that instructors trying the procedure described here for the first time be given close supervision and guidance by chief instructors, curriculum officers, or educational specialists. Particular attention should be paid to the information and theory the instructor plans to present. No more should be included than required to perform the training tasks in the Basic Curriculum Outline.

In developing instructional plans for the total instructional unit, its common and its individualized parts, the instructor is faced with the usual questions: At what times and for what purposes will the class be assembled? At what points will students be separated for a variety of purposes? Which enabling objectives can be attained by reading assignments? Which by PI? Which require extended discussion at strategic points? Which require individual supervision or conference to learn? What materials will be required, what space, what training aids?

In answering these questions the instructor, or instructor team, must determine which instructor is to prepare for what roles--lecturer, discussion leader, study supervisor, constructor and monitor of the administration of PI, of exercises, supervisor of mock-up learning time, leader of conferences with selected individuals concerning particular problems they are encountering or concerning ship type assignments to which the individual is going.

The instructor must also allocate time for the accomplishment of each objective. Time allotments sometimes depend on the order in which the tasks are trained. Between each MMA welding pass, for example, the surface must be smoothed by time consuming chipping and grinding* to prepare for the next pass. The more proficient a welder becomes the less he needs to perform this laborious task, since a perfect pass results in a surface ready for the next pass. "Chipping/grinding and cleaning are essentially simple to learn but quite time-consuming to perform. The extremely complex welding techniques required for contemporary welding are, in contrast, very difficult to learn. The trainee may take approximately one to two minutes to weld one pass and then consume from ten minutes to over an hour in cleaning and chipping/grinding. It is not uncommon for trainees to take <u>eight</u> to <u>twelve</u> hours on one qualification project requiring about eight passes or just <u>twelve minutes</u> of welding." (Abrams, Bishop, & Le Roy, 1969, p. 7)

Clearly, in training a welder, one does not wish to spend this kind of time on a lower level task which will become unnecessary when the higher level task is learned. Training exercises must be planned to permit learning how to make a sufficiently good pass to require little chipping and grinding, before spending time on this step in the process.

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* This operation for TIG welding is simple.

No matter what his role, the instructor prepares a guide for himself. The format will vary in accordance with the kind of role. There should be no effort to standardize it, except it should always contain the learning objective(s) to be achieved along with the job task(s). The only utility such a guide has is to guide the instructor in preparing for and conducting his instruction or to guide his substitute or successor. To guide either of these, the plan must be specific and clear.

In preparing the guide, the instructor focuses on the specific end-of-course or significant enabling objectives assigned to him to get students to achieve. This requires that he (1) provide the right learning sets; (2) specify his own lesson plan objectives that will make student achievement of the enabling objectives not only possible but efficient; (3) determine what method, or methods, of instruction he will use; (4) determine what training aids and other materials are needed; and (5) note how he will supervise or monitor the learning process of each student so that proper and swift knowledge of results--not only of progress, but also of specific errors--can be provided.

As the instructor specifies his lesson plan objectives, he must consider what additional exercises and tests or estimates of student learning he must develop for pacing his instruction and for improving his own methods. In specifying his own lesson plan objectives, the instructor must remember that he is continuing the job analysis to lower levels from the enabling task with which the analysis in Step 2 or 5 stopped. If he has any question of what the job incumbent tasks are that he should make action elements of lesson plan objectives, he should consult other job experts. This question of where the course designer should stop the development of the

Task Inventory and the instructor pick it up for his lesson planning purposes is troublesome. For the course designer to continue to the last detail makes the design process in effect result in the complete course: right down to what the instructor will do in the instructional situation. The point of view taken in this Manual is that, while it is sometimes necessary to do just this, there are differences to the degree to which it is required. It was hoped the job expert CICWO instructor could carry the analysis from where the design left off. In fact, this was one of the criteria for stopping the analysis. Likewise, it was felt the expert ET did not need everything spelled out. The welding case is different. Here there are so many and difficult problems about how the instruction should be conducted that professional assistance was needed in analyzing what the training problems really were. The skill analysis was therefore continued. It seemed better to incorporate this further analysis in lesson plan guidance (Appendix H) in a format similar to what instructors were accustomed to use at the Class "C" Welding School, rather than in the format of the Basic Curriculum Outline. An excerpt from this Lesson Plan Guidance document follows to illustrate the detail to which the analysis was carried.

Procedure to TIG weld a pass (process basically identical for all joints):

a. Strike arc:

(1) Make contact, without high frequency, between base materials and tungsten electrode.

(2) Establish arc with high frequency by holding tungsten electrode approximately 1/2" from base material (precise distance depends on intensity of high frequency adjustment).

b. Establish puddle at one end of joint.

c. Apply filler material at leading edge of puddle.

d. Commence travel, insuring fusion of both plates, with travel always toward filler material.

e. Continue travel, adding filler material as required, to produce a uniform weld bead.

f. Complete pass.

g. Withdraw filler material.

h. Stop forward travel.

i. Lift torch slowly until arc is broken; avoid melting ends of plates while breaking arc.

j. Repeat process as necessary to complete a multi-layer weld; however, clean each successive pass.

2. <u>Conduct of the Course</u>

Even with a Basic Curriculum Outline containing training tasks that are easy to construct and attach standards to, the problems of the instruction of a complex skill are by no means solved. It is the <u>conduct</u> of a course for a skill like welding that is the critical element in determining whether or not students learn efficiently. For the learning of such complex mental and physical skills close observation of the student is mandatory, especially during the initial phases of this learning. The reason for this is to enable the instructor to discover the cues the student is responding to, see that he makes the correct responses to

them, and provide him immediate feedback. In the training of the CICWO, attention must be given to ensuring the student is responding to the tactical situation and to the displays that contain information derived from it. In the training of troubleshooting skills close observation of the student during the early phases of his training is required to make sure he is developing good troubleshooting skills. A combination of feedback, prompting, discussion is required on an individual basis. For a skill like welding, the problem of discovering what cues the student is responding to and what feedback he is getting is extremely difficult. The task requires professional help and may take a long time to discover. A problem the course designer is faced with is whether instructors can, or can be trained to, observe consistently and discover the student's problem where complex skills are involved. Even if the instructor can observe in a manner that permits him to identify the student's problem, he still has the problem of finding ways to communicate just what it is the student is doing wrong and further to help him discover what he should do right.

Two points have been noted as we have observed instructors try to go from a Basic Curriculum Outline lesson planning. The first and major one is their strong tendency to maintain a knowledge or "knowledge about" orientation rather than the job assignment orientation required by the statement of the learning objectives in the Outline. Once this shift had been made--and it appeared to come as an insight--they were able to make some progress. It is obvious the shift in attitude toward training required by the present course design process will take time and guidance. The second observation concerned the ease with which

training tasks can be misinterpreted. Care in statement of job and training tasks has a large payoff here.

In planning and conducting his lessons the instructor must observe the principle that any discussion of theory, basic concepts, or other knowledge be managed in the context of its use. A good ET instructor, for example, will discuss troubleshooting in terms of a class exercise using the functional block diagram in developing concepts of functional allocation and in disentangling closely related ones for troubleshooting purposes. The instructor, also, should observe the principle that no more discussion of basic concepts and theory is included than needed to perform the training tasks.

Lesson planning is also influenced by learning principles. Four of the most important have already been discussed, adapting to individual differences and establishing a learning set, i.e., "a context or framework should be taught for the student to use in organizing what he is to learn," "variety in the day's instruction maintains motivation and helps overcome monotony and fatigue;" "spaced practice and review promote learning;" "teaching highly similar tasks to close to one another interferes with learning." Others that should be taken into account are: "a variety of practice materials should be provided;" "the student should be told what he is expected to learn," i.e., he should be given the learning objectives for each instructional unit as well as for the course as a whole; "instruction should be paced by the students' learning rates," "the student should be given knowledge of his progress and his errors,"

These last two principles enable the student to put his effort where it is needed. The good instructor will not only inform the student of what he is to learn, but make every effort to keep track of his progress and identify his particular difficulties in order to provide him more than a simple statement that he did or did not meet the standards of a particular objective.

The usual discussion of the lesson plan stresses the need for motivating the student. Our experience suggests that in a course for adults designed and carried out in terms of the principles discussed, such problems diminish. The nature of the training tasks produced by the course design process makes it clear to the student that what he is learning he is gong to use. Feeding back to the student in highly specific terms what his problems are and helping overcome them, giving him a clear understanding that whether he passes or fails the course is dependent only on his readiness to undertake his job assignment has a desirable side effect. As it is now, students and instructors consider themselves natural enemies. Each tries to outguess the other in terms of what to test and what to study to pass the test. This situation tends to transfer to the training situation the unfavorable connotation of the term evaluation, stemming basically from the effect of fitness reporting on careers. So far as the training situation is concerned, the negative attitude prevailing toward tests and evaluation might change markedly for the better if the instructor's role were seen by the student as a help to reaching specified standards of performance on specific tasks required on his next duty assignment. Learning could become, as it should be, a cooperative student-instructor adventure, with much to be gained by each party.

TABLE OF CONTENTS

FIGURES

CHAPTER XI

STEP 10. IMPROVING THE COURSE

Despite every effort and the greatest of skill in course design, it will be a rare event for a course to achieve all of its objectives for all of its students or be conducted in the most efficient manner on its first administration. Conduct of the course and its subsequent improvement are therefore integral parts of a course design process. The link between course conduct and course improvement is provided by a program of evaluation. As already noted, the relationship between performance on enabling and end-of-course exercises can be particularly illuminating by pointing to instructional methods which need improvement. Enabling tasks have been trained for as separate units earlier in the course where they were the action elements of enabling objectives. If the instructor has been alert, he has a record of how well the student has performed on the task as a single unit. The difference between performance on the task performed alone and in the context of a complex exercise shows how well the student transfers his learning to the more complex shipboard-like task.

How to measure student attainment of objectives with what kind of tests has already been discussed. It remains only to stress the use of the results for course improvement. The starting point is the number of students who do or do not attain each and every learning objective. This information starts the instructor on the quest for reasons: (1) where instructional problems are located and (2) where there exists the possibility of making instructional procedures more efficient. If few meet an objective, the instructor must do some detective work. Is proper feedback being provided? Is an inappropriate

method being used? Is too much time being spent on the "nice to know"? Has too little time been allowed? Too little practice on exercises? Is there something wrong with the course sequence? Making a change in the condition suspected, the instructor can tell from change in the test result whether he has hit a cause of the poor learning. If he has not, he continues his search.

Should all students attain an objective, the time devoted to the instruction may be reduced. If all still attain the objective, it can be reduced still more. Over time, this procedure will result in the discovery of optimum time allotments.

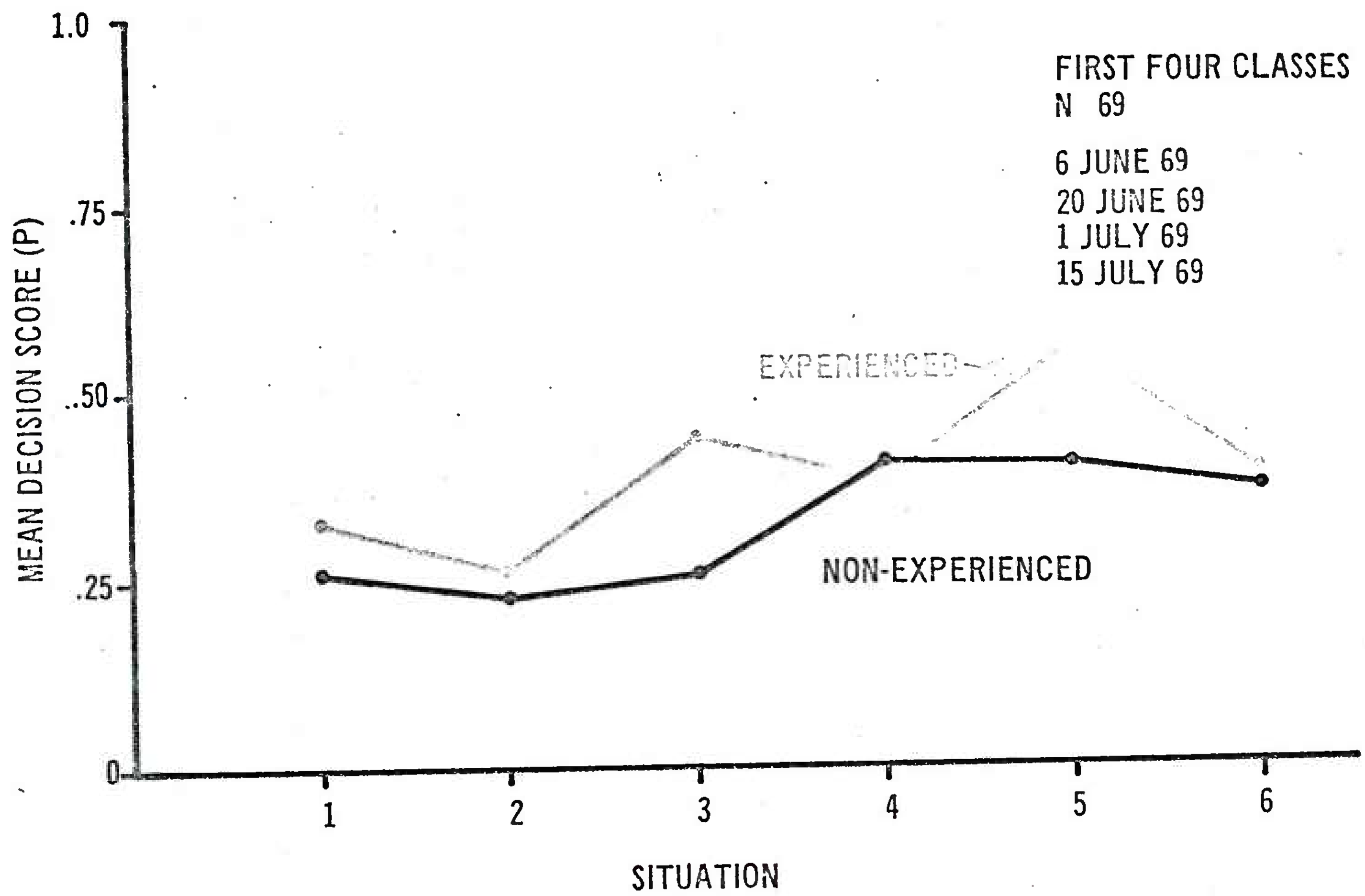
One complication here is that the tests must remain the same over a series of courses in order to evaluate the impact of changes. This does not mean that tests should never be changed. They will undoubtedly need improvement like everything else related to instruction. It does mean that the need for change in evaluation instruments should be studied very carefully and that changes be made after a series of courses, the time of change being related to what the instructor has been altering in the course. It should be noted that the manner in which the evaluation procedures have been tied into the training tasks reduces the likelihood of radical changes in evaluation procedures being required.

Step 10 then, is essentially a feedback step based on the information gained from the use of the tests developed to measure student attainment of objectives. The reasons for failure to attain objectives must be discovered and corrected unless one is satisfied to make a change and trust to luck. Experience teaches that the lady is not often kind when it comes to improving training.

The CICWO course offers an illustration of the value of tests in the improvement of the instruction. The Monitoring I test, as described in conjunction with its development of exercises in Step 5, has been administered to several classes. The complete results are described elsewhere (Riley & McCutcheon, 1970). But the results of one test are disappointing as can be noted in Figure 9. The number of errors detected, relative to those possible, particularly since the job experts agreed they were relatively simple, is small. There are a number of ways that the result might be explained. The validity of the test, as reflected in its faithful replication of the job tasks, the objective nature of the scoring, suggest that the manner of teaching the early course units where the specifics that are applied to the exercise are learned, may be faulty. Many of these units are in terms of PI. This unexpectedly poor attainment of the end-of-course objectives is being investigated, with particular emphasis on improving both learning programs and the means of providing the learning sets. It is tests like this, used in a manner like this that are the heart of evolutionary improvement of a course.

Course changes suggested by the partial application of the present design procedure to the AN/SPA-34 course are more emphasis on (1) training exercises for skills, especially skills involved in the end-of-course, e.g., skills in using test equipment; (2) systematic testing, both pre- and post; and (4) organizational flexibility for adapting to individual differences in both experience and rate of learning. In the Class "C" Welding School, major changes are concerning individualization of the course to permit closer observation of the student as he learns the welding process and reduction in the number of lectures.

FIG. 9. MONITORING I EXERCISE FOR CICWO COURSE K–2G–351
MEAN DECISION SCORE/SITUATION: EXPERIENCED VS NON-EXPERIENCED PERSONNEL



Courses are often changed on other than a test basis, such as student critiques, suggestions by others, and ideas from educational periodicals. All of these are poor reeds for basic course improvement. Students do not take into account the course mission. Neither [illegible] others who look at a curriculum. Students have not been through the course design process to understand how decisions concerning the inclusion of this or that objective, division of training between ship and shore and so forth, were made. Neither have these others. The ideas in periodicals, while sound in the abstract, may not be applicable in the particular context. Good use of tests for the purpose of improving a course can result in a payoff that would be hard to match by any other means, once the course is designed in terms of the procedure described in this Manual. <u>There is no other solid basis for ensuring that changes are improvements and not merely changes</u>.

Critiques may have some value in improving administrative practices. Occasionally use of a specially devised critique form aimed at a limited and specific set of problems may provide useful information. For this small value, they have a major disadvantage. They focus the instructor's attention on what the students, particularly any who happen to be of higher rank, think of him and his methods. His attention, on the contrary, should be focused on <u>what the students have learned</u> and so expect to be judged by his superiors. Doing away with any reference to instructional matters in critiques helps emphasize training as a cooperative venture in learning and will do much to improve student, instructor, and supervisory relationships.

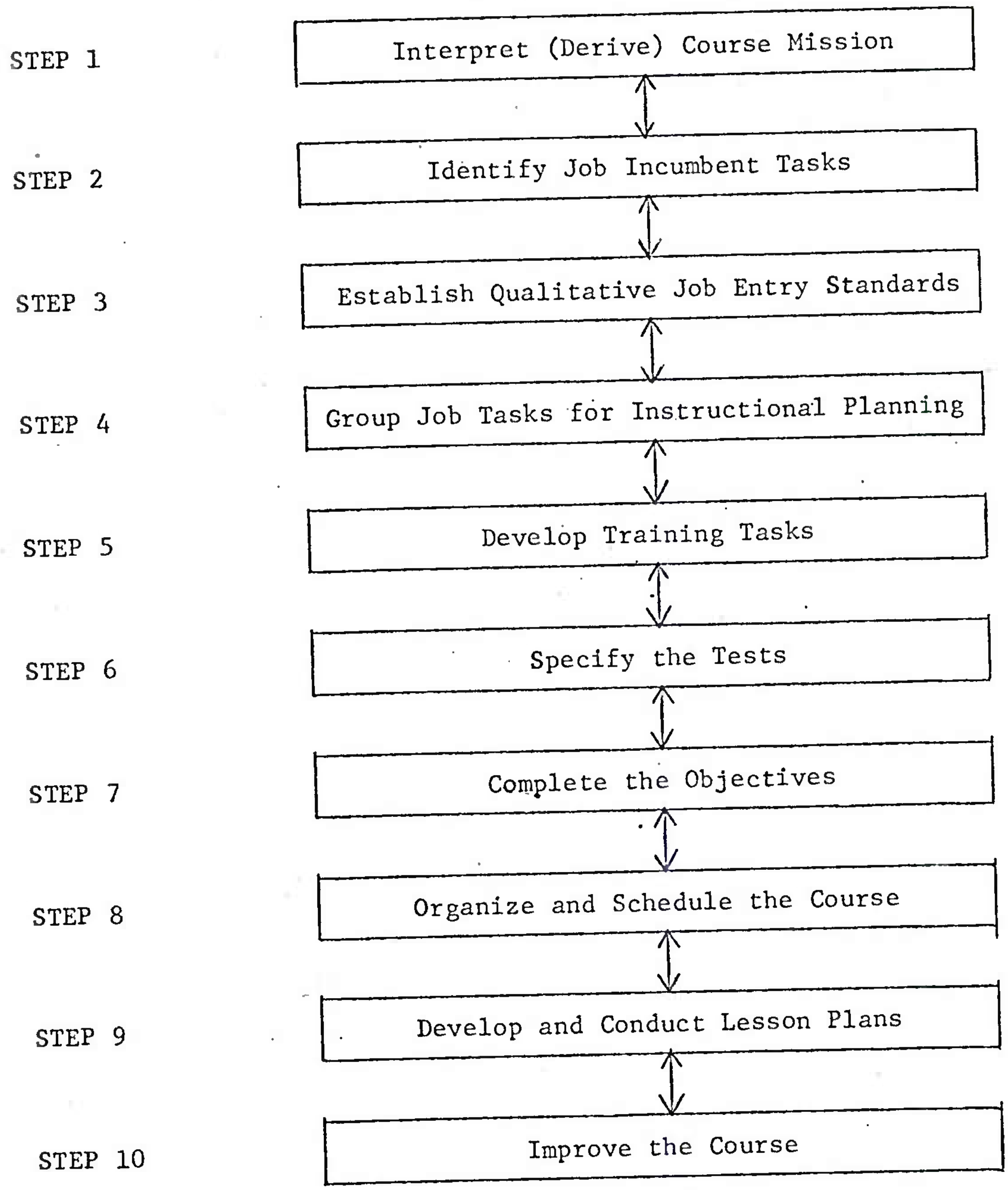


Fig. 10. Training Course Design Steps.

APPENDIX A

TASK INVENTORY FOR THE COMBAT INFORMATION CENTER WATCH OFFICER

1.0 Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently. (3)

1.1 Monitors CIC personnel during a normal steaming CIC watch on a combatant ship steaming independently. (3)

1.1.1 Monitors surface search operator in the search for and detection of surface, subsurface, and low flying air contacts and the processing, display, and reporting of contact data. (2)

1.1.1.1 Detects incorrectly set controls on a surface search radar repeater. (1)

1.1.1.1.1 Discriminates between good and bad radarscope presentations.

1.1.1.2 Detects incorrect reporting procedures of radarscope operator. (2)

1.1.1.3 Detects radarscope plotting errors of CPAs and course and speed. (2)

1.1.1.3.1 Determines size and composition of contacts from a radarscope plotting head. (1)

1.1.1.3.2 Solves CPA of surface contact from a radarscope plotting head. (1)

1.1.2 Monitors intercept search operator in search for and detection of electronic emissions, and the processing and reporting of intercept data. (4)

1.1.2.1 Detects incorrect reporting procedures and/or omissions on part of intercept search operator. (4)

1.1.2.2 Ensures that intercept search operator maintains an alert watch for new intercepts in assigned guard band. (2)

1.1.3 Monitors radiotelephone operators in receiving, processing, and transmitting data. (2)

1.1.3.1 Detects procedural errors committed by radiotelephone operators. (2)

1.1.3.2 Detects incorrect interpretations of radiotelephone signals and makes the applicable corrections. (2)

1.1.3.2.1 Decodes and encodes signals in applicable signal books. (1)

(Appendix continued on next page)

1.1.3.3 Ensures that all required emergency radiotelephone nets are patched to CIC. (3)

1.1.3.4 Ensures that correct ASW communication links are established. (4)

1.1.4 Monitors sound powered telephone talkers in receiving, transmitting, and processing data. (2)

1.1.4.1 Detects incorrect procedures of sound powered telephone talker. (2)

1.1.5 Monitors maneuvering board plotters in plotting and processing following problems: (1) CPA, (2) course and speed of contact(s), and (3) course and speed of own ship to avoid. (2)

1.1.5.1 Solves the following problems on the maneuvering board: (1) CPA, (2) course and speed of contact(s), and (3) course and speed of own ship to avoid. (1)

1.1.6 Monitors DRT operator in plotting and analysis of radar and ECM data on the DRT. (2)

1.1.7 Monitors surface summary plotter in maintaining all required information up-to-date on the surface summary plot. (2)

1.1.8 Monitors surface status board keeper in maintaining all required information up-to-date on the surface status board. (2)

1.1.9 Monitors the dissemination of key information to both internal and external stations. (3)

1.1.10 Ensures that current SAR instructions, procedures, and OpOrders are readily available in CIC. (2)

1.1.11 Monitors air search radar operator in search for and detection of air contacts and the processing, display, and reporting of contact data. (3)

1.1.12 Monitors height finding radar operator in carrying out his assigned duties. (4)

1.1.12.1 Compares height finding radar information with other pertinent data, stored and recently collected. (4)

1.1.13 Interacts with CIC Watch Coordinator to ensure that CIC maintains an alert posture for submarine contacts and that a minimal time ensues between receipt of initial submarine contact and preparedness to prosecute contacts. (5)

1.1.13.1 Monitors CIC watch personnel in the transition from a normal watch to an ASW posture. (5)

(Appendix continued on next page)

1.1.14 Supervises the implementation of radar guards, EMCON conditions, and time-sharing plans, briefing watch personnel as required. (5)

1.1.15 Supervises the Watch Coordinator in the performance of the following tasks: (1) watch personnel duty assignments, (2) rotation of watch personnel, and (3) on-the-job training of watch personnel. (5)

1.2 Evaluates the CIC information of a ship steaming independently. (3)

1.2.1 Evaluates information from a surface search radar. (2)

1.2.2 Evaluates a surface contact. (2)

1.2.2.1 Recognizes tactics of surface contact as hostile. (3)

1.2.2.2 Determines that a risk of collision exists for own ship and a surface contact. (1)

1.2.2.2.1 Evaluates DRT plot to determine Rules of the Road for a given contact situation, correlating own ship's course and speed, target position, and target angle. (1)

1.2.2.2.2 Extracts correct maneuvers and signals for a risk of collision from current Rules of the Road. (1)

1.2.2.3 Selects the proper action to combat an attack by high speed surface craft. (3)

1.2.3 Reports to the CIC officer and/or operations officer all atmospheric refractivity information vital to the electronic equipment of his own ship. (3)

1.2.3.1 Plots all applicable chart data from daily RADFO messages. (3)

1.2.4 Evaluates intercepted electronic signals rapidly as to type and function of emitter and as many other specifics as possible. (2)

1.2.4.1 Locates electronic emission information in appropriate publications. (2)

1.3 Recommends to Conn all maneuvers and/or other actions required of own ship steaming independently. (3)

1.4 Serves as CIC communicator when necessary. (1)

1.4.1 Receives and transmits on a radiotelephone using correct procedures, standard equipment operation techniques, and correct security precautions. (1)

(Appendix continued on next page)

1.4.1.1 Translates significant evaluated data into appropriate format for dissemination (coded or plain language). (1)

1.4.1.2 Selects the proper system for transmission of evaluated data. (1)

1.4.2 Transmits evaluated data over MC or ship's service telephone when necessary for rapidity or clarification. (1)

2.0 <u>Serves as a CICWO in a CIC involved in supporting a ship maneuvering in formations and screens</u>. (3)
NOTE: All tasks listed under 1.0 apply here.

2.1 Monitors CIC personnel involved in supporting a ship maneuvering in formations and screens. (3)

2.1.1 Monitors surface search radar operator in obtaining bearings and ranges to Guide and other force units and the processing, display, and reporting of radar data. (2)
Task 1.1.1 included here.

2.1.2 Monitors maneuvering board plotters in processing maneuvering data. (2).
Task 1.1.5 included here.

2.1.2.1 Solves the following problems on the maneuvering board: (1) Course and speed to new station, and (2) time of arrival on station. (1)

2.1.2.2 Detects incorrectly plotted positions of Guide and other force units on the maneuvering board. (2)

2.1.2.3 Detects incorrect course and speed to station maneuvering board solutions and time to arrive on station computations. (2)

2.1.3 Monitors DRT operator in plotting and analyzing movements of Guide and other force units during formation and screen maneuvers. (2)
Task 1.1.6 included here.

2.1.3.1 Detects inaccurate DRT plot of Guide's track or track of other designated unit. (2)

2.1.4 Monitors formation diagram keeper in maintaining all required information up-to-date on the formation diagram. (2)

2.2 Evaluates the CIC information of a ship steaming in formations and screens. (3)

2.2.1 Determines the actions required of own ship to complete an ordered maneuver. (3)

(Appendix continued on next page)

2.2.1.1 Locates maneuvering information in applicable publications. (3)

2.3 Recommends to Conn the actions required of own ship to complete an ordered maneuver. (3)

2.4 Determines course and speed of Guide and own ship's courses and speeds to new stations from the plot maintained by the DRT operator. (3)

3.0 Serves as a CICWO in a CIC participating in a man overboard recovery. (1)
NOTE: All tasks listed under 1.0 and 2.0 to apply here.

3.1 Monitors CIC personnel participating in a man overboard recovery. (1)

3.1.1 Monitors DRT operator in carrying out man overboard procedures promptly and accurately when warning is received. (1)
Tasks 1.1.6 and 2.1.3 apply here.

3.1.1.1 Detects when DRT is set to scale other than 200 yards/inch. (1)

3.1.1.2 Detects incorrectly estimated plot of a man overboard. (1)

3.1.1.3 Detects improperly plotted wind direction. (1)

3.1.1.4 Detects the failure of the DRT operator to make continuous reports of ranges and bearings to the man overboard. (1)

3.2 Evaluates CIC information of ship involved in man overboard recovery operation. (1)

3.2.1 Selects significant man overboard information for dissemination to various command levels. (1)

3.3 Recommends to Conn all required maneuvering actions and whistle signals based on CIC man overboard data. (1)

3.4 Serves as DRT operator during man overboard operations when required. (1)

3.4.1 Plots all relevant information on DRT when man overboard warning is heard. (1)

3.4.2 Sets the DRT scale to 200 yards/inch upon receiving word of man overboard.

(Appendix continued on next page)

4.0 Serves as a CICWO in a CIC participating in a Search and Rescue (SAR) mission. (4)
NOTE: All tasks listed under 1.0 and 2.0 apply here.

4.1 Monitors CIC personnel participating in a SAR mission. (4)

4.1.1 Ensures that all SAR incidents are reported to the cognizant SAR coordinator. (4)

4.2 Evaluates a distress or emergency call on a CIC radiotelephone speaker. (2)

4.3 Recommends to Conn what maneuvers should be utilized to conduct a particular SAR mission. (3)

5.0 Serves as a CICWO in a CIC involved in the prosecution of air contacts in an AAW Condition III. (3)
NOTE: All tasks listed under 1.0 and 2.0 apply here.

5.1 Monitors CIC personnel involved in the prosecution of air contacts in an AAW Condition III. (3)

5.1.1 Monitors air vertical plot plotters in maintaining all required information up-to-date on the vertical plot. (3)

5.1.2 Monitors radiotelephone operators in transmitting, receiving, and processing air contact data.
Task 1.1.3 applies here.

5.1.3 Interacts with CIC watch supervisor in the assignment of relief personnel in the enlisted watch team without the disruption of ongoing activities in the event a higher condition of readiness is ordered. (4)

5.1.4 Monitors watch personnel engaged in the conversion of bearings and ranges to appropriate coordinate systems. (2)

5.1.5 Monitors the correct display of information obtained from the NTDS, Link 14, TTY readout. (3)

5.2 Serves as AAW evaluator in an AAW Condition III.

5.2.1 Selects significant air contact data for dissemination to various command levels. (2)

5.3 Recommends to Conn when ship should go to General Quarters. (4)

5.4 Interacts with AIC in exchange of data required by the AIC and that required to maintain status boards in CIC or to report to other stations. (5)

(Appendix continued on next page)

5.5 Briefs the AAW evaluator and CIC officer and ensures a smooth transition of watch personnel in the event a higher condition of readiness is ordered. (5)

5.5.1 Provides the AAW evaluator with all pertinent air contact data when he reports ready to relieve the CICWO. (5)

6.0 Serves as a CICWO in a CIC involved in the prosecution of suspected submarine contacts in ASW Condition III. (3)
NOTE: All tasks listed under 1.0 and 2.0 apply here.

6.1 Monitors CIC personnel involved in the prosecution of a suspected submarine contact in an ASW Condition III. (3)

6.1.1 Monitors radiotelephone operator in receiving and processing incoming submarine contact data. (3)
Task 1.1.3 applies here.

6.1.2 Monitors DRT operators in plotting and processing submarine data. (2)
Task 1.1.6 applies here.

6.1.2.1 Detects incorrectly set controls for a DRT being used in ASW. (2)

6.1.2.2 Detects incorrect plots on the DRT of own ship, assist ship(s), and submarine contact(s). (3)

6.1.2.3 Detects incorrectly labeled plots on the DRT. (3)

6.1.2.4 Ensures passage from the DRT of all submarine data to the appropriate CIC stations. (3)

6.2 Serves as an ASW Evaluator in an ASW Condition III. (3)

6.2.1 Evaluates a subsurface contact situation as to classification, possible identity, and probable intentions of contact. (3)

6.2.2 Selects significant contact data for dissemination to various command levels. (3)

6.2.2.1 Determines the reliability and significance of CIC ASW information with respect to tactical requirements. (3)

6.2.2.2 Correlates CIC data with information from stored sources. (3)

6.2.2.3 Determines for recommendation to Conn, appropriate submarine and/or torpedo evasion maneuvers. (2)

6.2.2.3.1 Extracts appropriate submarine and/or torpedo evasion maneuvers from applicable publications.

(Appendix continued on next page)

6.3 Recommends to Conn the appropriate maneuvers to place own ship in position to conduct urgent attacks or evade detection, as applicable. (3)

6.3.1 Determines from DRT plot the course, speed, and aspect of a suspected submarine contact. (3)

6.3.2 Recommends to Conn when ship should go to General Quarters. (4)

6.4 Receives, transmits, and receipts for incoming submarine contact data when necessary, using correct procedures, standard equipment operation techniques, and proper security measures. (3)
Task 1.3 applies here.

6.5 Provides ASW evaluator with all pertinent submarine contact information when he reports ready to relieve the watch. (5)

6.6 Ensures a smooth transition of watch posture and personnel without disruption of ongoing watch activities, in the event a higher condition of readiness is ordered. (5)

7.0 Relieves the watch. (3)
NOTE: Tasks listed under 1.0, 2.0, 3.0, 4.0, 5.0, and 6.0 are all brought to bear in performing the following tasks.

7.1 Checks stored data prior to relieving the watch. (1)

7.1.1 Sights, using checklist if desired, stored data required to administer the watch, assuming custody for classified material. (1)

7.1.2 Determines information, events, and procedures applicable to his watch by reviewing: pertinent operation orders and operations plans, CO's night orders, pass-down-the-line (PDL) log, and pertinent messages. (2)

7.1.3 Amplifies and interprets data derived from operation orders, night orders, PDL log, and messages by referring to doctrinal publications, fleet and ship standard operating procedures (SOP), intelligence materials, and RADFO messages. (2)

7.2 Determines the status of the various systems in CIC prior to relieving the watch. (4)

7.2.1 Inspects, interprets, and evaluates surface summary plot to determine presence, location, and degree of threat of surface contacts. (3)

7.2.2 Inspects, interprets, and evaluates air vertical plot to determine presence, location, and degree of threat of air contacts. (4)

(Appendix continued on next page)

7.2.3 Inspects, interprets, and evaluates electronic warfare status board to determine information pertinent to radar and intercept search guards, EMCON, and current or anticipated intercepts. (4)

7.2.4 Inspects, interprets, and evaluates communications status board to determine current communications organization and capability. (3)

7.2.5 Inspects, interprets, and evaluates equipment status board to determine operating status of all major CIC equipment. (3)

7.2.6 Determines if the external controls of the radars are set for their assigned functions. (2)

7.2.7 Determines if the remote units of all internal communications equipment are manned and functioning for the assigned requirements. (2)

APPENDIX B

BASIC CURRICULUM OUTLINE FOR THE COMBAT INFORMATION CENTER WATCH OFFICER COURSE

TOPICS

Concepts of CIC/Mock-up Tour
Techniques of Radarscope Maneuvering
Radiotelephone Communications Procedures (Programmed Instruction)
Communication Status Boards (Programmed Instruction)
External Communications (Programmed Instruction)
Internal Communications (Programmed Instruction)
The DRT and Geographic Plot (Individual Instruction)
Maneuvering Board (Programmed Instruction)
General Radar Indicator Familiarization (Individualized Instruction)
Rules of the Road for CIC (Programmed Instruction)

Formation Diagram and Surface Summary Plot
Allied Naval Signal Book (Programmed Instruction)
Surface Tracking Mock-ups (Individualized Instruction)
Multi-Net Communications Mock-up
CIC Publications
Line Formations (Programmed Instruction)
Single Line Formations Mock-up
Monitoring the Surface Radar
DRT Plotting for Man Overboard
Initial CIC Response to Man Overboard

Shipboard Response to Man Overboard
SAR Communications
SAR Organization
Circular Formations (Programmed Instruction)
Types and Characteristics of Surface Screens
Monitoring CIC Personnel (I) (Classroom Exercises)
Evasive Maneuvers
Potential Nuclear War Communications Requirements for the CICWO
Monitoring CIC Personnel (II)
Screening Mock-up

ASW Plotting
The ASW CIC
ASW Communications
ASW Urgent Attacks
Small Craft Tactics
Combating High Speed Surface Craft
ASW High Speed Surface Craft Classroom Exercise
Rapid ECM Evaluation (Programmed Instruction)
ASW Evaluation
Display Methods in AAW

AAW Communications
NTDS Link 14
AAW Classroom Exercise
Monitoring CIC Personnel (III)

APPENDIX B

BASIC CURRICULUM OUTLINE FOR THE COMBAT INFORMATION CENTER WATCH OFFICER COURSE*

INSTRUCTIONAL BLOCK I

Concepts of CIC/
Mock-up Tour

<u>SHIPBOARD TASK:</u> 7.2.5 — Inspects, interprets, and evaluates equipment status board to determine operating status of all major CIC equipment.

Training Task 1: Detects from an equipment status board in a mock-up, all inoperative or malfunctioning CIC equipment. (DW)

Standards: 100% accuracy.

Training Task 2: Identifies selected CIC equipment in a CIC mock-up at the request of an instructor.

Standards: 100% accuracy.

Techniques of
Radarscope Maneuvering

<u>SHIPBOARD TASK:</u> 1.1.1.3.2 — Solves CPA of surface contact from a radarscope plotting head.

Training Task 3: Performs above task in a mock-up exercise.

Standards: Standard fleet tolerances.

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*Shipboard tasks asterisked (*) are the action elements of end-of-course objectives. Those without the * are action elements of enabling objectives. Other codes used:

DW - A day's work in CIC, an exercise running throughout the course.

AAW - Anti-air warfare classroom exercise.

ASW - Anti-submarine warfare/high speed surface craft classroom exercise.

(Appendix continued on next page)

APPENDIX B (Continued)

SHIPBOARD TASK: 1.1.1.1.3.1 — Determines size and composition of contacts from a radarscope plotting head.

Training Task 4: Performs above task in a mock-up exercise.

Standards: 100% accuracy.

SHIPBOARD TASK: 1.1.1.3 — Detects radarscope plotting errors of CPAs and course and speed.

Training Task 5: Student performs above task with radarscope plots presented on slides in a comprehensive classroom exercise.

Standards: Four out of five erroneous plots must be detected.

Radiotelephone Communications Procedures Programmed Instruction

SHIPBOARD TASK: 1.4.1 — Receives and transmits on a radiotelephone using correct procedures, standard equipment operation techniques, and correct security precautions.

Training Task 6: Performs above task in a mock-up exercise.

Standards: Correct procedures must be used 80% of the time and security precautions with 100% accuracy.

Communication Status Boards Programmed Instruction

SHIPBOARD TASK: 7.2.4 — Inspects, interprets, and evaluates communications status board to determine current communications organization and capability.

Training Task 7: Student performs above task with status board displays given on slides in the classroom in a comprehensive exercise. (DW)

Standards: Must make four out of four correct determinations.

(Appendix continued on next page)

APPENDIX B (Continued)

External Communications
Programmed Instruction

SHIPBOARD TASK: 1.1.3 — Monitors radiotelephone operators in receiving, processing, and transmitting data.

SHIPBOARD TASK: 1.1.3.1 — Detects procedural errors committed by radiotelephone operators.

Training Task 8: Detects and corrects procedural, reporting format, and security errors made on a classroom presented audio-tape of a hypothetical CIC radiotelephone net.

Standards: Student must detect each of ten errors within thrity seconds of their commission.

Internal Communications
Programmed Instruction

SHIPBOARD TASK: 7.2.7 — Determines if the remote units of all internal communications equipment are manned and functioning for the assigned requirements.

Training Task 9: Determines the internal communication requirements in a CIC mock-up and ensures that remote units are manned and equipment functioning prior to the first mock-up exercise. (DW)

Standards: All malfunctions and unmanned equipment must be detected.

SHIPBOARD TASK: 1.1.4 — Monitors sound powered telephone talkers in receiving, transmitting, and processing data.

SHIPBOARD TASK: 1.1.4.1 — Detects incorrect procedures of sound powered telephone talkers.

Training Task 10: Detects and corrects procedural and substantive errors committed on an audio-tape of hypothetical sound powered telephone transmissions in a series of comprehensive exercises.

Standards: 80% of all errors must be corrected.

(Appendix continued on next page)

SHIPBOARD TASK: 1.4.2 — Transmits evaluated data over MC or ship's service telephone when necessary for rapidity or clarification.

Training Task 11: Discriminates, in a classroom tape/slide exercise, between CIC information to be sent by MC or ship's service telephone and the information to be sent by slower methods.

Standards: 75% accuracy.

SHIPBOARD TASK: 1.4.1.2 — Selects the proper system for transmission of evaluated data.

Training Task 12: Performs above task in an individualized mock-up exercise.

Standards: 100% accuracy.

The DRT and Geographic Plot Individualized Instruction

SHIPBOARD TASK: 1.1.6 — Monitors DRT operator in plotting and analysis of radar and ECM data on the DRT.

Training Task 13: Detects and corrects DRT plotting errors as displayed on slides in a comprehensive tape/slide classroom exercise.

Standards: Four out of four errors must be detected.

Maneuvering Board Programmed Instruction

SHIPBOARD TASKS: 1.1.5.1, 2.1.2.1 — Solves the following problems on the maneuvering board: CPA, course and speed of contact(s), course and speed to avoid, course and speed to new station, and time of arrival on station.

Training Task 14: Same as shipboard task.

Standards: Same as fleet tolerances.

(Appendix continued on next page)

APPENDIX B (Continued)

SHIPBOARD TASK: 1.1.5 — Monitors maneuvering board plotters in plotting and processing the following problems: (1) CPA, (2) course and speed of contact(s), and (3) course and speed of own ship to avoid.

Training Task 15: Detects the errors and makes the applicable corrections in a prepared series of maneuvering board solutions of CPAs, courses and speeds of contacts, and courses and speeds of own ship to avoid as presented in a classroom exercise.

Standards: All errors must be corrected within forty-five seconds of seeing the plot.

General Radar Indicator Familiarization Individualized Instruction

SHIPBOARD TASKS: 1.1.1.1, 7.2.6 — Determines if external controls of all radars are properly set for the assigned function of the equipment and, if not, directs adjustment of equipment as required.

SHIPBOARD TASK: 1.1.1.1.1 — Discriminates between good and bad radarscope presentations.

Training Task 16: Discriminates between good and bad radarscope presentations, given a series of slides in the classroom showing various radar repeater displays.

Standards: Student must detect seven out of ten radarscopes with incorrectly set controls.

SHIPBOARD TASK: 1.1.1.2 — Detects incorrect reporting procedures of radarscope operator.

Training Task 17: Detects and corrects incorrect reporting procedures of an audio-tape of hypothetical radarscope operator reports.

Standards: 80% of erroneous reports must be detected.

(Appendix continued on next page)

APPENDIX B (Continued)

Rules of the Road for CIC Programmed Instruction

SHIPBOARD TASK: 1.2.2.2.1 — Evaluates DRT plot to determine Rules of the Road for a given contact situation, correlating own ship's course and speed, target position, and target angle.

SHIPBOARD TASK: 1.2.2.2 — Determines that a risk of collision exists for own ship and a surface contact.

Training Task 18: Determines if a risk of collision exists with another vessel, and if so, what action is required in accordance with the Rules of the Road; given a series of classroom slides showing various DRT traces and radarscope presentations. Five situations will be presented.

Standards: 100% accuracy.

SHIPBOARD TASK: 1.2.2.2.2 — Extracts correct maneuvers and signals for a risk of collision from current Rules of the Road.

Training Task 19: Extracts the applicable rule, including whistle signals and own ship maneuvers, for series of situations presented by tape/slide in the classroom, from CG-169, Rules of the Road, International-Inland.

Standards: No errors.

Formation Diagram and Surface Summary Plot

SHIPBOARD TASK: 7.2.1 — Inspects, interprets, and evaluates surface summary plot to determine presence, location, and degree of threat of surface contacts.

SHIPBOARD TASK: 2.1.4 — Monitors formation diagram keeper in maintaining all required information up-to-date on the formation diagram.

SHIPBOARD TASK: 1.1.7 — Monitors surface summary plotter in maintaining all required information up-to-date on the surface summary plot.

(Appendix continued on next page)

Training
Task 20: Determines presence, location, relative motion, and degree of threat of surface contacts and any plotting errors by inspecting, interpreting, and evaluating data on the Surface Summary Plot and Formation Diagram as presented on slides in a comprehensive classroom exercise.

Standards: 100% accuracy.

Allied Naval Signal Book
Programmed Instruction

SHIPBOARD TASK: 1.1.3.2.1 — Decodes and encodes signals in the applicable signal books.

SHIPBOARD TASK: 1.1.3.2 — Detects incorrect interpretations of radiotelephone signals and makes the applicable corrections.

Training
Task 21: Decodes and encodes signals in the Allied Naval Signal Book, HO 103, and any fleet tactical signal supplement, in a classroom exercise.

Standards: Each signal must be decoded or encoded within three minutes of being received.

Surface Tracking
Mock-up/Individualized
Instruction

SHIPBOARD TASKS: 1.2.1, 1.2.2 — Evaluates a surface contact using surface search radar presentation, maneuvering board, and DRT plot.

SHIPBOARD TASK: 1.1.8 — Monitors surface status board keeper in maintaining all required information up-to-date on the surface status board.

Training
Task 22: Performs above tasks in a fifteen-minute mock-up exercise.

Standards: Every final evaluation must be correct. All errors must be corrected.

(Appendix continued on next page)

Multi-Net
Communications Mock-up

SHIPBOARD TASK: 1.4 — Serves as CIC communicator when necessary.

Training Task 23: Performs above task in a mock-up exercise.

Standards: 80% of all transmissions must be correct.

CIC Publications

SHIPBOARD TASK: 7.1.3 — Amplifies and interprets data derived from operation orders, night orders, PDL log, and messages by referring to doctrinal publications, fleet and ship standard operating procedures (SOP), intelligence materials, and RADFO messages.

Training Task 24: Extracts requested information from the following publications in a comprehensive classroom exercise: Maneuvering publications**, ACP 125, Brevity Code Words, applicable TacNotes, 1st/7th Fleet SOP, USS FAAWTC SORM, and staff designed intelligence materials. (DW)

Standards: Student must find any given piece of information within three minutes.

SHIPBOARD TASK: 1.4.1.1 — Translates significant evaluated data into appropriate format for dissemination (coded or plain language).

Training Task 25: Decodes and encodes messages with the aid of fleet doctrinal publications**, and a FAAWTC designed operation order in a classroom exercise. (DW)

Standards: Within three minutes of message receipt.

**In the actual curriculum, the publications are all listed.

(Appendix continued on next page)

Monitoring CIC
Personnel (I)

SHIPBOARD TASK: *1.0	Serves as a CICWO during a normal steaming CIC watch on a combatant ship steaming independently.
SHIPBOARD TASK: 1.1	Monitors CIC personnel during a normal steaming CIC watch on a combatant ship steaming independently.
SHIPBOARD TASK: 1.2	Evaluates the CIC information of a ship steaming independently.
SHIPBOARD TASK: 1.3	Recommends to Conn all maneuvers and/or other actions required of own ship steaming independently.
SHIPBOARD TASK: 1.1.9	Monitors the dissemination of key information to both internal and external stations.

Training Task 26: In a classroom exercise, three slides will be displayed simultaneously depicting various CIC status boards, plots, and equipment accompanied by audiotaped transmissions of sound powered telephone and radiotelephone communications. The situations will present problems of a ship steaming independently. Information from the various sources is not always compatible.

The student must (1) compare the information with displays for their compatibility; (2) detect and record plotting, display, and communications errors; (3) assess, in writing, the immediate situation as shown on the slides; and (4) state in writing what recommendation CIC should make to the bridge.

Standards: 80% accuracy.

(Appendix continued on next page)

APPENDIX B (Continued)

INSTRUCTIONAL BLOCK II

Line Formations
Programmed Instruction

SHIPBOARD TASK: 2.1.1 — Monitors surface search radar operator in obtaining bearings and ranges to Guide and other force units and the processing, display, and reporting of radar data.

Training Task 27: Detects and corrects incorrect reporting and display errors from a classroom tape/slide demonstration of a radar operator giving ranges and bearings to a line formation Guide.

Standards: Four out of five errors must be plotted.

SHIPBOARD TASK: 2.1.2.2 — Detects incorrectly plotted positions of Guide and other force units on the maneuvering board.

SHIPBOARD TASK: 2.1.2.3 — Detects incorrect course and speed to station maneuvering board solutions and time to arrive on station computations.

Training Task 28: Detects the errors and makes the applicable corrections in a prepared series of maneuvering board solutions of line formation maneuvering problems presented in a classroom exercise.

Standards: All errors must be corrected within forty-five seconds of seeing the plot.

SHIPBOARD TASK: 2.1.3 — Monitors DRT operator in plotting and analyzing movements of Guide and other force units during formation and screen maneuvers.

SHIPBOARD TASK: 2.1.3.1 — Detects inaccurate DRT plot of Guide's track or track of other designated unit.

SHIPBOARD TASK: 2.4 — Determines course and speed of Guide and own s[illegible] course and speed to new stations from the plot [illegible]tained by DRT operator.

(Appendix continued on next page)

Training Task 29: Detects incorrect line formation plots and new station solutions in a classroom drill presented tape/slide demonstration of various DRT plots. Ten incorrect plots will be shown.

Standards: All incorrect plots must be detected within forty-five seconds.

SHIPBOARD TASK: 2.1.4 Monitors formation diagram keeper in maintaining all required information up-to-date on the formation diagram.

Training Task 30: Detects incorrect line formation plots and new station solutions in a classroom drill presented on a tape/slide demonstration of various formation diagram plots; five incorrect plots will be shown.

Standards: All errors must be detected within thirty seconds.

SHIPBOARD TASK: 2.2.1 Determines the actions required of own ship to complete an ordered maneuver.

SHIPBOARD TASK: 2.2.1.1 Locates maneuvering information in applicable publications.

Training Task 31: Determines in a mock-up, what maneuvers are required of own ship to respond to a given line formation order and communicates that determination to mock-up control.

Standards: Within three minutes of initial signal transmission.

Single Line Formations Mock-up

SHIPBOARD TASK: 2.2 Evaluates the CIC information of a ship steaming in formations and screens.

Training Task 32: Evaluates the CIC information in a mock-up exercise simulating a ship steaming in line formations.

Standards: Final evaluations must be correct 80% of the time.

(Appendix continued on next page)

<u>SHIPBOARD TASK:</u> 2.3 — Recommends to Conn the actions required of own ship to complete an ordered maneuver.

Training Task 33: Recommends to mock-up control the actions required of own ship in a simulated line formation.

Standards: Recommendations must be correct 80% of the time.

<u>SHIPBOARD TASK:</u> 2.1.2.1 — Solves course and speed to, and time of arrival on, new station using the maneuvering board.

Training Task 34: Performs above task in a mock-up exercise.

Standards: Standard fleet tolerances.

Monitoring the Surface Radar

<u>SHIPBOARD TASK:</u> 1.1.1 — Monitors surface search radar operator in search for and detection of surface, subsurface, and low flying air contacts and the processing, display, and reporting of contact data.

<u>SHIPBOARD TASK:</u> 2.1.1. — Monitors surface search radar operator in obtaining bearings and ranges to Guide and other force units and the processing, display, and reporting of radar data.

Training Task 35: Detects and corrects incorrect reporting and display errors from a tape/slide demonstration of a radar operator giving ranges and bearings to the Guide and other force units.

Standards: Four out of five errors must be detected.

DRT Plotting for Man Overboard

<u>SHIPBOARD TASK:</u> 3.1.1 . — Monitors DRT operator in carrying out man overboard procedures accurately and promptly when warning is received.

(Appendix continued on next page)

APPENDIX B (Continued)

SHIPBOARD TASK: 3.1.1.1	Detects when DRT is set to scale other than 200 yards/inch.
SHIPBOARD TASK: 3.1.1.2	Detects incorrectly estimated plot of a man overboard.
SHIPBOARD TASK: 3.1.1.3	Detects improperly plotted wind direction.
SHIPBOARD TASK: 3.1.1.4	Detects the failure of the DRT operator to make continuous reports of ranges and bearings to the man overboard.
Training Task 36:	Performs above tasks in a mock-up exercise. DRT plotter will make five minor plotting errors, two major plotting errors, and two reporting errors in a fifteen minute period.
Standards:	All errors must be detected.
SHIPBOARD TASK: 3.4	Serves as DRT operator during man overboard operations, when required.
SHIPBOARD TASK: 3.4.2	Sets the DRT to 200 yards/inch upon receiving word of man overboard.
Training Task 37:	Performs above task in a mock-up exercise.
Standards:	Maximum time: 15 seconds.
SHIPBOARD TASK: 3.4.1	Plots all relevant information on DRT when man overboard warning is heard.
Training Task 38:	Performs above task in a mock-up exercise.
Standards:	Plots must be within 50 yards of simulated position.

Initial CIC Response to Man Overboard

SHIPBOARD TASK: 3.2.1	Selects significant man overboard data for dissemination to various command levels.

(Appendix continued on next page)

SAR Organization

SHIPBOARD TASK: 1.1.10 — Ensures that current SAR instructions, procedures, and OpOrders are readily available in CIC.

Training Task 43: Performs above task, using checklist if desired, in a mock-up exercise.

Standards: All applicable publications must be located.

SHIPBOARD TASK: 4.1.1 — Ensures that all SAR incidents are reported to the cognizant SAR coordinator.

Training Task 44: Performs above task in a mock-up exercise.

Standards: No omissions.

Training Task 45: Lists, in a classroom exercise, the SAR organization as presented in a FAAWTC designed OpOrder.

Standards: No omissions.

SHIPBOARD TASK: 4.3 — Recommends to Conn what maneuvers should be utilized to conduct a particular SAR mission.

Training Task 46: Extracts from current fleet SOP, in a classroom drill, the individual ship maneuvers to be utilized to bring about specific types of rescues (i.e., surface craft malfunction, downed pilot in friendly waters, downed pilot in hostile waters, etc.)

Standards: Each maneuver must be extracted within five minutes.

Training Task 47: Recognizes the existence of a SAR incident in a mock-up exercise.

Standards: Within two minutes of receiving applicable inputs.

Circular Formations
Programmed Instruction

SHIPBOARD TASK: 2.1.1 — Monitors surface search radar operator in obtaining bearings and ranges to Guide and other force units and the processing, display, and reporting of radar data.

(Appendix continued on next page)

Training Task 39: Discriminates between significant and insignificant man overboard details in response to a series of written hypotheticals.

Standards: 100% accuracy.

Shipboard Response To Man Overboard

SHIPBOARD TASK: 3.3 Recommends to Conn maneuvering actions and whistle signals based on CIC man overboard information.

Training Task 40: Recommends that mock-up control the maneuvering actions and whistle signals which should be carried out, based on CIC mock-up man overboard data and the type of recovery requested by FAAWTC instructors.

Standards: 100% correct recommendations.

Training Task 41: Recognizes, in a classroom exercise, DRT traces which show records of the following man overboard maneuvers: Williamson Turn, the Y, the Race Horse (two turn), the Single Turn, and the Anderson Turn. (DW)

Standards: No errors.

SAR Communications

SHIPBOARD TASK: 1.1.3.3 Ensures that required emergency radiotelephone nets are patched to CIC.

Training Task 42: Detects discrepancies between requirements of a SAR frequency plan contained within a furnished OpOrder and slides of various ship's communications status boards displaying SAR communications in that ship's CIC. (DW)

Standards: Student must detect seven discrepancies out of the ten presented in a ten-minute period.

(Appendix continued on next page)

APPENDIX B (Continued)

Training Task 48:	Detects and corrects incorrect reporting and display errors from a tape/slide demonstration of a radar operator giving ranges and bearings to a formation Guide in a series of circular formations.
Standards:	Four out of five errors must be detected.
SHIPBOARD TASK: 2.1.2.3	Detects incorrect course and speed to new station maneuvering board solutions and time to arrive on station computations.
Training Task 49:	Detects the errors and makes the applicable corrections in a prepared series of maneuvering board solutions of circular formation maneuvering solutions presented in a classroom exercise; five solutions will be shown.
Standards:	All errors must be corrected within forty-five seconds of seeing the plot.
SHIPBOARD TASK: 2.1.3.1	Detects inaccurate DRT plot of Guide's track or track of other designated unit.
SHIPBOARD TASK: 2.4	Determines course and speed of Guide and own ship's courses and speeds to new stations from the plot maintained by the DRT operator.
Training Task 50:	Detects incorrect circular formation plots and maneuvering solutions in a classroom drill presented on a tape/slide display of various DRT plots; ten incorrect plots will be shown.
Standards:	All incorrect plots must be detected within forty-five seconds.
SHIPBOARD TASK: 2.1.4	Monitors formation diagram keeper in maintaining all required information up-to-date on the formation diagram.
Training Task 51:	Detects incorrect circular formation plots and new station solutions in a classroom drill presented on a tape/slide demonstration of various formation diagram plots; five incorrect plots will be shown.
Standards:	All incorrect plots must be detected within thirty seconds.

(Appendix continued on next page)

SHIPBOARD TASK: 2.2.1 — Determines the actions required of own ship to complete an ordered maneuver.

Training Task 52: Determines, in a mock-up exercise, what maneuvers are required of own ship to respond to a given circular formation order and communications that determination to mock-up control.

Standards: Within three minutes of signal transmission.

Types and Characteristics of Surface Screens

SHIPBOARD TASK: 2.1.1 — Monitors surface search radar operator in obtaining bearings and ranges to Guide and other force units and the processing, display, and reporting of radar data.

Training Task 53: Detects and corrects incorrect reporting and display errors from a tape/slide demonstration of a radar operator giving ranges and bearings to a screen Guide in a variety of screens.

Standards: Four out of five errors must be detected.

SHIPBOARD TASK: 2.1.2 — Monitors maneuvering board plotters in processing maneuvering data.

Training Task 54: Detects the errors and makes the applicable corrections in a prepared series of maneuvering board solutions of screen problems, in a classroom exercise.

Standards: All errors must be corrected within forty-five seconds of seeing the plot.

SHIPBOARD TASK: 2.1.3.1 — Detects inaccurate DRT plot of Guide's track or track of other designated units.

Training Task 55: Detects incorrect screening plots and maneuvering solutions in a classroom drill presented on a tape/slide display of various DRT plots; ten incorrect plots will be presented.

Standards: All incorrect plots must be detected within forty-five seconds.

(Appendix continued on next page)

APPENDIX B (Continued)

SHIPBOARD TASK: 2.1.4 — Monitors formation diagram keeper in maintaining all required information up-to-date on the formation diagram.

Training Task 56: Detects incorrect screening plots and new station solutions in a classroom drill presented on a tape/slide demonstration of various formation diagram plots.

Standards: Within three minutes of presentation.

SHIPBOARD TASK: 2.2.1 — Determines the actions required of own ship to complete an ordered maneuver.

Training Task 57: Determines, in a mock-up exercise, what maneuvers are required of own ship to respond to a given screen order and communicates that determination to mock-up control.

Standards: Within three minutes of signal transmission.

Evasive Maneuvers

SHIPBOARD TASK: 6.2.2.3 — Determines, for recommendation to Conn, appropriate submarine and/or torpedo evasion maneuvers.

Training Task 58: Recommends to mock-up exercise control evasive action for mock-up generated submarine and torpedo attacks.

Standards: Within one minute of the need becoming apparent.

SHIPBOARD TASK: 6.2.2.3.1 — Extracts appropriate submarine and/or torpedo evasion maneuvers from applicable publications.

Training Task 59: Utilizes applicable publications in determining submarine and torpedo evasive maneuvers in a classroom exercise.

Standards: Each decision must be made within 90 seconds.

Training Task 60: Sets up a zig zag plan from applicable publication in a classroom exercise.

Standards: 100% accuracy.

(Appendix continued on next page)

APPENDIX B (Continued)

Potential Nuclear War
Communications Requirements
for the CICWO

SHIPBOARD TASK: 1.2.3 — Reports to the CIC Officer and/or Operations Officer all atmospheric refractivity information vital to the electronic equipment of his own ship.

SHIPBOARD TASK: 1.2.3.1 — Plots all applicable chart data from daily RADFO messages.

Training Task 61: Performs above task in a classroom drill and makes applicable reports, in writing, to course instructor.

Standards: No errors.

Monitoring CIC
Personnel (II)

SHIPBOARD TASK: *2.0 — Serves as a CICWO in a CIC involved in supporting a ship maneuvering in formations and screens.

SHIPBOARD TASK: 2.1 — Monitors CIC personnel involved in supporting a ship maneuvering in formations and screens.

SHIPBOARD TASK: 2.2 — Evaluates the CIC information of a ship steaming in formations and screens.

SHIPBOARD TASK: 2.3 — Recommends to Conn the actions required of own ship to complete an ordered maneuver.

Training Task 62: In a classroom exercise, three slides will be displayed simultaneously depicting various CIC status boards, plots, and equipment accompanied by audio-taped transmissions of sound powered telephone and radiotelephone communications. The situations will present problems of a ship steaming in formations and screens. Information from the various sources is not always compatible.

The student must (1) compare the information with displays for their compatibility; (2) detect and record plotting, display, and communications errors; (3) assess, in writing, the immediate situation as shown on the slides; and (4) state in writing what recommendation CIC should make to the bridge.

Standards: With 80% accuracy.

(Appendix continued on next page)

APPENDIX B (Continued)

INSTRUCTIONAL BLOCK III

Screening Mock-up

SHIPBOARD TASK: 2.4 — Determines course and speed of Guide and own ship's courses and speeds to new station from the DRT plot.

Training Task 63: Determines course and speed of screen Guide and own ship's course and speed to new screen station from the DRT plot in a mock-up exercise.

Standards: Standard fleet tolerances.

SHIPBOARD TASK: 2.1.2.1 — Solves course and speed to new screen station and time to arrive to new screen station on the maneuvering board.

Training Task 64: Performs above task in a mock-up exercise.

Standards: Standard fleet tolerances.

SHIPBOARD TASK: 2.2 — Evaluates the CIC information of a ship steaming in various formations and screens.

Training Task 65: Performs above task in mock-up screening exercise.

Standards: All final evaluations must be correct 80% of the time.

ASW Plotting

SHIPBOARD TASKS: 6.1.2, 6.2.2 — Monitors DRT operators in plotting and processing submarine data and selects significant data for dissemination to various command levels.

SHIPBOARD TASK: 6.1.2.1 — Detects incorrectly set controls for a DRT being used in ASW.

SHIPBOARD TASK: 6.1.2.2 — Detects incorrect plots on the DRT of own ship, assist ship(s), and submarine contact(s).

SHIPBOARD TASK: 6.1.2.3 — Detects incorrectly labeled plots on the DRT.

SHIPBOARD TASK: 6.1.2.4 — Ensures passage of all submarine data from the DRT to the appropriate CIC stations.

(Appendix is continued on next page)

APPENDIX B (Continued)

Training Task 66: Detects and corrects errors committed by DRT operator in plotting and processing submarine data, such errors being presented by tape/slide in a classroom exercise (ASW).

Standards: Student must detect seven errors out of ten in a fifteen-minute period.

Training Task 67: Given a series of written hypothetical ASW inputs, selects in writing the data to be disseminated from CIC to the bridge and/or ASW plot. (DW)

Standards: 90% of all necessary data must be selected.

The ASW CIC

<u>SHIPBOARD TASK:</u> 6.1.1 Monitors radiotelephone operator in receiving and processing incoming submarine contact data.

Training Task 68: Detects and corrects procedural and security errors made on a classroom presented audiotape of a hypothetical ASW radiotelephone net.

Standards: Student must detect each of ten errors within thirty seconds of their commission.

<u>SHIPBOARD TASK:</u> 6.2.2.1 Determines the reliability and significance of CIC ASW information with respect to tactical requirements.

Training Task 69: Given a list of CIC ASW informational data, checks off those data which are reliable and significant.

Standards: 80% accuracy.

<u>SHIPBOARD TASK:</u> 6.2.2.2 Correlates CIC data with information from stored sources.

Training Task 70: Performs above task in a comprehensive classroom exercise. (ASW)

Standards: Decisions reached as a result of such correlations must be a minimum of 80% correct.

(Appendix is continued on next page)

APPENDIX B (Continued)

SHIPBOARD TASK: 6.3.1 — Determines from DRT plot the course, speed, and aspect of a suspected submarine contact.

Training Task 71: Performs above task in a comprehensive classroom exercise. (ASW)

Standards: Standard Fleet tolerances.

SHIPBOARD TASK: 6.3.2 — Recommends to Conn when ship should go to General Quarters.

Training Task 72: States, in writing, when in a comprehensive classroom exercise he would recommend putting his ship at General Quarters. (ASW)

Standards: Must be within one situation of optimum point.

ASW Communications

SHIPBOARD TASK: 6.4 — Receives, transmits, and receipts for submarine contact data when necessary, using correct procedures, standard equipment operation techniques, and proper security measures.

Training Task 73: Performs above task in a mock-up exercise.

Standards: Student will use correct procedures a minimum of 80% of the time and proper security measures with 100% accuracy.

Training Task 74: Locates and uses correct brevity code words and reporting tables in all applicable publications in a mock-up exercise.

Standards: With 100% accuracy.

SHIPBOARD TASK: 1.1.3.4 — Ensures that correct ASW communication links are established.

Training Task 75: Ensures that all radiotelephone CIC equipment is functioning in an ASW mock-up exercise.

Standards: No errors.

(Appendix is continued on next page)

APPENDIX B (Continued)

ASW Urgent Attacks

SHIPBOARD TASK: 6.3 — Recommends to Conn the appropriate maneuvers to place own ship in position to conduct urgent attacks or evade detection, as applicable.

Training Task 76: Detects incorrect recommendations of a hypothetical CICWO in an ASW posture as presented in a classroom tape/slide exercise. Four incorrect recommendations will be made. (ASW)

Standards: All incorrect recommendations must be detected and corrected.

Training Task 77: Extracts from applicable publications the procedures for launching an urgent attack on a submarine in a classroom exercise. (ASW)

Standards: No errors.

Small Surface Craft Tactics

SHIPBOARD TASK: 1.2.2.1 — Recognizes tactics of surface contact as hostile.

Training Task 78: Performs above task by looking at a series of DRT traces in a classroom exercise. (ASW)

Standards: Student must recognize all tracings representative of hostile surface contact tactics and make no incorrect interpretations of tracings representative of friendly tracks.

Training Task 79: Determines the type of surface craft attack, correlating the geographic area, types of craft available to any potential enemy, and the tactics of various potential attackers in a mock-up exercise.

Standards: No errors.

(Appendix is continued on next page)

APPENDIX B (Continued)

Combating High
Speed Surface Craft

SHIPBOARD TASK: 1.2.2.3 — Selects the proper action to combat an attack by high speed surface craft.

Training Task 80: Recommends to exercise control the action required to combat an attack by computer generated high speed surface craft in a mock-up exercise.

Standards: No errors.

ASW/High Speed
Surface Craft
Classroom Exercise

SHIPBOARD TASKS: 1.2.2.1, 1.2.2.3 — Recognizes tactics of a surface contact as hostile and recommends to Conn the proper action to combat the hostile contact.

Training Task 81: Performs above task in a classroom exercise, given a series of slides showing CIC displays of surface contact information.

Standards: All simulated hostile actions must be detected.

SHIPBOARD TASK: *6.0 — Serves as a CICWO in a CIC involved in the prosecution of suspected submarine contacts in ASW Condition III.

SHIPBOARD TASK: 6.1 — Monitors CIC personnel involved in the prosecution of a suspected submarine contact in an ASW Condition III.

SHIPBOARD TASK: 6.2 — Serves as an ASW Evaluator in an ASW Condition III.

SHIPBOARD TASK: 6.2.1 — Evaluates a subsurface contact situation as to classification, possible identity, and probable intentions of contact.

(Appendix is continued on next page)

Training Task 82: In a classroom exercise, three slides will be displayed simultaneously depicting various CIC status boards, plots, and equipment accompanied by audio-taped transmission of sound powered telephone and radiotelephone communications. The situations will present problems of a ship in ASW Condition III. A high speed surface craft attack will also be simulated. Information from the various sources is not always compatible.

The student must (1) compare the information with displays for their compatibility; (2) detect and record plotting, display, and communications errors; (3) assess, in writing, the immediate situation as shown on the slides; and (4) state in writing what recommendation CIC should make to the bridge.

Standards: With 80% accuracy.

(Appendix is continued on next page)

APPENDIX B (Continued)

INSTRUCTIONAL BLOCK IV

Rapid ECM Evaluation
Programmed Instruction

SHIPBOARD TASK: 1.2.4 — Evaluates intercepted electronic signals rapidly as to type and function of emitter and as many other specifics as possible.

SHIPBOARD TASK: 1.2.4.1 — Locates electronic emission information in appropriate pubications.

Training Task 83: Student will perform the above tasks, given sets of signals, in a classroom exercise. (DW)

Standards: Each hypothetical intercept must be evaluated within three minutes.

AAW Evaluation

SHIPBOARD TASK: 5.2.1 — Selects significant air contact data for dissemination to various command levels.

Training Task 84: Performs above task in a classroom tape/slide exercise. (AAW)

Standards: No errors.

The AAW CIC

SHIPBOARD TASK: 1.1.11 — Monitors air search radar operator in search for and detection of air contacts and the processing, display, and reporting of contact data.

Training Task 85: Detects and corrects reporting and display errors from a tape/slide demonstration of an air search radar operator in a typical AAW Condition III environment. (AAW)

Standards: Seven out of ten errors must be detected.

(Appendix is continued on next page)

APPENDIX B (Continued)

SHIPBOARD TASK: 1.1.12 — Monitors height finding radar operator in carrying out his assigned duties.

SHIPBOARD TASK: 1.1.12.1 — Compares height finding radar information with other pertinent data, stored and recently collected.

Training Task 86: Compares height finding radar information with other pertinent data presented in a comprehensive classroom exercise. (AAW)

Standards: Three out of five inconsistencies must be found.

SHIPBOARD TASK: 5.1.3 — Interacts with CIC Watch Supervisor in the assignment of relief personnel in the enlisted watch team without the disruption of ongoing activities, in the event a higher condition of readiness is ordered.

Training Task 87: Designs a chart showing how he would assign enlisted personnel (by rate) to specific CIC positions in an AAW Condition I.

Standards: All major assignments must be correct.

SHIPBOARD TASK: 1.1.2.1 — Detects incorrect reporting procedures and/or omissions on part of intercept search operator.

SHIPBOARD TASK: 1.1.2.2 — Ensures that intercept search operator maintains an alert watch for new intercepts in assigned guard band.

Training Task 88: Detects and corrects reporting errors committed by intercept search operator as presented in a comprehensive classroom exercise. (AAW)

Standards: Four out of five errors must be detected.

Display Methods in AAW

SHIPBOARD TASK: 5.1.4 — Monitors watch personnel engaged in the conversion of bearings and ranges to appropriate coordinate systems.

Training Task 89: Converts to X, Y coordinates on a handout a series of audio taped bogey reports in ranges and bearings from own ship in a classroom drill. (AAW)

(Appendix is continued on next page)

Standards: Within standard acceptable tolerances.

SHIPBOARD TASK: 5.1.1 Monitors air vertical plot plotters in maintaining all required information up-to-date on the vertical plot.

Training Task 90: Detect and correct errors and omissions in displays of vertical plots presented by tape/slide in a classroom drill. (AAW)

Standards: Student must detect seven out of ten errors presented in a ten-minute period.

AAW Communications

SHIPBOARD TASK: 5.1.2 Monitors radiotelephone operators in receiving, transmitting and processing air contact data.

Training Task 91: Receives, transmits, and processes air contact data on a radiotelephone net in a mock-up exercise.

Standards: Correct procedures must be used 80% of the time and security precautions with 100% accuracy. Processing must be to meet the minimum standards of current fleet requirements.

NTDS Link 14

SHIPBOARD TASK: 5.1.5 Monitors the correct display of information obtained from the NTDS Link 14, TTY readout.

Training Task 92: Plots and interprets a series of NTDS Link 14, TTY readouts as presented in a classroom handout. (DW)

Standards: Student must plot ten out of ten inputs within three minutes.

AAW Classroom Exercise

SHIPBOARD TASK: 1.1.2 Monitors intercept search operator in search for and detection of electronic emissions, and the processing and reporting of intercept data.

(Appendix is continued on next page)

SHIPBOARD TASK: *5.0	Serves as a CICWO in a CIC involved in the prosecution of air contacts in an AAW Condition III.
SHIPBOARD TASK: 5.1	Monitors CIC personnel involved in the prosecution of air contacts in an AAW Condition III.
SHIPBOARD TASK: 5.2	Serves as an AAW Evaluator in an AAW Condition III.
SHIPBOARD TASK: 5.3	Recommends to Conn when ship should go to General Quarters.

Training Task 93: In a classroom exercise, three slides will be displayed simultaneously depicting various CIC status boards, plots, and equipment, accompanied by audio-taped transmissions of sound powered telephone and radiotelephone communications. The situations will present problems of a ship steaming in an AAW Condition III. Information from the various sources is not always compatible.

The student must (1) compare the information with displays for their compatibility; (2) detect and record plotting, display, and communications errors; (3) assess, in writing, the immediate situation as shown on the slides, and (4) state in writing what recommendation CIC should make to the bridge.

Standards: 80% accuracy.

(Appendix is continued on next page)

INSTRUCTIONAL BLOCK V

Monitoring CIC
Personnel (III)

SHIPBOARD TASK: *3.0 — Serves as a CICWO in a CIC participating in a man overboard recovery.

SHIPBOARD TASK: 3.1 — Monitors CIC personnel participating in a man overboard recovery.

SHIPBOARD TASK: 3.2 — Evaluates CIC information of a ship involved in a man overboard recovery.

SHIPBOARD TASK: *4.0 — Serves as a CICWO in a CIC participating in a Search and Rescue (SAR) mission.

SHIPBOARD TASK: 4.1 — Monitors CIC personnel participating in a SAR mission.

SHIPBOARD TASK: 4.2 — Evaluates a distress or emergency call on a CIC radiotelephone speaker.

Training Task 94: In a classroom exercise, three slides will be displayed simultaneously depicting various CIC status boards, plots, and equipment accompanied by audio-taped transmissions of sound powered telephone and radiotelephone communications. The situations will present problems of a ship involved in a SAR mission and in a man overboard recovery. Information from the various sources is not always compatible.

The student must (1) compare the information with displays for their compatibility; (2) detect and record plotting, display, and communications errors; (3) assess, in writing, the immediate situation as shown on the slides; and (4) state in writing what recommendation CIC should make to the bridge.

Standards: 80% accuracy.

Relieving
the Watch

SHIPBOARD TASK: *7.0 — Relieves the watch.

(Appendix is continued on next page)

APPENDIX B (Continued)

SHIPBOARD TASK: 7.1 — Checks stored data prior to relieving the watch.

SHIPBOARD TASK: 7.1.1 — Sights, using checklist if desired, stored data required to administer the watch, assuming custody for classified material.

SHIPBOARD TASK: 7.1.2 — Determines information, events, and procedures applicable to his watch by reviewing: pertinent operation orders and operations plans, CO's night orders, pass-down-the-line (PDL) log, and pertinent messages.

SHIPBOARD TASK: 7.2 — Determines the status of the various systems in CIC prior to relieving the watch.

Training Task 95: Performs the watch relieving procedures in a classroom exercise by proceeding through a checklist in the presence of an instructor.

Standards: All major watch relieving procedures must be performed.

Day's Work in CIC

SHIPBOARD TASK: 7.2.5 — Inspects, interprets, and evaluates equipment status board to determine operating status of all major CIC equipment.

Training Task 96: Detects from an equipment status board in a mock-up, all inoperative or malfunctioning CIC equipment.

Standards: 100% accuracy.

SHIPBOARD TASK: 7.2.2 — Inspects, interprets, and evaluates air vertical plot to determine presence, location, and degree of threat of air contacts.

Training Task 97: Performs above task in a mock-up exercise.

Standards: All major threats must be detected.

SHIPBOARD TASK: 7.2.4 — Inspects, interprets, and evaluates communications status board to determine current communications organization and capability.

(Appendix is continued on next page)

APPENDIX B (Continued)

Training Task 98: Student performs above task with status board displays given on slides in the classroom in a comprehensive exercise.

Standards: Must make four out of four correct determinations.

SHIPBOARD TASK: 7.2.3 Inspects, interprets, and evaluates electronic warfare status board to determine information pertinent to radar and intercept search guards, EMCON, and current or anticipated intercepts.

Training Task 99: Performs above task in a mock-up exercise and reflects determinations in a written summary.

Standards: 90% of current information must be noted.

SHIPBOARD TASK: 7.2.7 Determines if the remote units of all internal communications equipment are manned and functioning for the assigned requirements.

Training Task 100: Determines the internal communciation requirements in a CIC mock-up and ensures that remote units are manned and equipment functioning prior to the first mock-up exercise.

Standards: All malfunctions and unmanned equipment must be detected.

SHIPBOARD TASK: 7.1.3 Amplifies and interprets data derived from operation orders, night orders, PDL log, and messages by referring to doctrinal publications, fleet and ship standard operating procedures (SOP), intelligence materials, and RADFO messages.

Training Task 101: Extracts requested information from the following publications,** ACP 125, Brevity Code Words, applicable TacNotes, 1st/7th Fleet SOP, USS FAAWTC SORM, and staff designed intelligence materials.

Standards: Student must find any given piece of information within three minutes.

**In the actual curriculum, the publications are all listed.

(Appendix is continued on next page)

SHIPBOARD TASK: 1.4.1.1 — Translates significant evaluated data into appropriate format for dissemination.

Training Task 102: Decodes and encodes messages with the aid of fleet doctrinal publications,** and a FAAWTC designed operation order in a classroom exercise.

Standards: Within three minutes of message receipt.

Training Task 103: Recognizes, in a classroom exercise, DRT traces which show records of the following man overboard maneuvers: Williamson Turn, the Y, the Race Horse (two turn), the Single turn, and the Anderson Turn.

Standards: No errors.

SHIPBOARD TASK: 1.1.3.3 — Ensures that required emergency radiotelephone nets are patched to CIC.

Training Task 104: Detects discrepancies between requirements of a SAR frequency plan contained within a furnished OpOrder and slides of various ship's communications status boards displaying SAR communications in that ship's CIC.

Standards: Student must detect seven discrepancies out of the ten presented in a ten-minute period.

SHIPBOARD TASK: 1.2.3.1 — Plots all applicable chart data from daily RADFO messages.

Training Task 105: Performs above task in a classroom drill.

Standards: No errors.

SHIPBOARD TASK: 1.2.4 — Evaluates intercepted electronic signals rapidly as to type and function of emitter and as many other specifics as possible.

Training Task 106: Student will perform the above task, given set of signals in a classroom exercise handout.

Standards: Each hypothetical intercept must be evaluated within three minutes.

**In the actual curriculum, the publications are all listed.

(Appendix is continued on next page)

APPENDIX B (Continued)

Shipboard Tasks (Covered in Handouts) to be Learned
in Terms of "Knowledge About" Standards

SHIPBOARD TASK: 1.1.13	Interacts with CIC watch coordinator to ensure that CIC maintains an alert posture for submarine contacts and that a minimal time ensues between receipt of initial submarine contact and preparedness to prosecute contacts.
SHIPBOARD TASK: 1.1.13.1	Monitors CIC watch personnel in the transition from a normal watch to an ASW posture.
SHIPBOARD TASK: 1.1.14	Supervises the implementation of radar guards, EMCON conditions, and time-sharing plans, briefing watch personnel as required.
SHIPBOARD TASK: 1.1.15	Supervises the watch coordinator in the performance of the following tasks: (a) watch personnel duty assignments, (b) rotation of watch personel, and (c) on-the-job training of watch personnel.
SHIPBOARD TASK: 5.4	Interacts with AIC in exchange of data required by the AIC and that required to maintain status boards in CIC or to report to other stations.
SHIPBOARD TASK: 5.5	Briefs the AAW evaluator and CIC officer and ensures a smooth transition of watch personnel in the event a higher condition of readiness is ordered.
SHIPBOARD TASK: 5.5.1	Provides the AAW evaluator with all pertinent air contact data when he reports ready to relieve the CICWO.
SHIPBOARD TASK: 6.5	Provides ASW evaluator with all pertinent submarine contact information when he reports ready to relieve the watch.
SHIPBOARD TASK: 6.6	Ensures a smooth transition of watch posture and personnel without disruption of ongoing watch activities, in the event a higher condition of readiness is ordered.

APPENDIX C

TASK INVENTORY FOR AN ELECTRONIC EQUIPMENT MAINTENANCE COURSE AN/SPA-34

*1.0 Extracts information from Technical Manual (TM) and/or Maintenance Requirement Cards (MRCs) required to operate the AN/SPA-34, perform and document maintenance actions. (1)

1.1 Extracts information from the schematics, general and detailed. (1)

1.2 Extracts information from the text. (1)

1.3 Extracts information from tables. (1)

2.0 Sets up, checks, and operates the following equipment in accordance with procedure in the applicable Operator's Manual (OM): (1)

*2.1 AN/USM-140c oscilloscope to measure amplitude and time interval of signals. (1)

2.1.1 Energizes the AN/USM-140c. (1)

2.1.2 Sets the focus and intensity. (1)

2.1.3 Determines and sets the required sweep time for any given signal within the capabilities of the AN/USM-140c. (1)

2.1.4 Determines and sets the required vertical sensitivity for any signal within the capabilities of the AN/USM-140c. (1)

2.1.5 Synchronizes the sweep with the unknown signal to obtain a stable presentation. (1)

2.1.6 Compensates the scope probe. (1)

2.1.7 Determines and sets the AN/USM-140c for AC or DC input when given a signal to measure. (1)

2.1.8 Connects probe and ground lead to circuit under test. (1)

*2.2 AN/PSM-4c multimeter to measure voltages, currents, and values of resistance. (1)

2.2.1 Sets the function switch to the proper function for measurement of the unknown. (1)

(Appendix continued on next page)

APPENDIX C (Continued)

2.2.2 Sets Range Switch to the proper range for measurement of the unknown. (1)

2.2.3 Plugs leads into proper jacks on meter for measurement of a given unknown. (1)

2.2.4 Connects probe and ground lead to circuit under test. (1)

2.2.5 Reads values of voltage, current, and resistance as indicated on the meter scale. (1)

*2.3 AN/USM-113 to (a) trigger the AN/SPA-34 and (b) measure the RANGE RING accuracy. (1)

3.0 Performs, checks and tests, following all equipment and personnel safety precautions. (1)

*3.1 Performs indicator checks as an aid in locating a malfunction. (1)

3.1.1 Operates in semidarkness the AN/SPA-34 Indicator Group in all modes. All applicable equipment and personnel safety precautions must be observed. (1)

3.1.1.1 Locates controls, relying on their shape and position for their identification. (2)

3.1.1.2 Performs preliminary settings for operation of the AN/SPA-34. (1)

3.1.1.3 Starts the indicator. (1)

3.1.1.4 Adjusts indicator to proper intensity; then focuses. (1)

3.1.1.5 Discriminates between video signals and background noise. (1)

3.1.1.6 Finds range and bearing of a target from sweep origin. (1)

3.1.1.7 Finds range and bearing between targets. (1)

3.1.1.8 Performs close observation of a target. (1)

3.1.1.9 Discriminates between centered and noncentered presentations. (1)

3.1.1.10 Performs AEW tracking and repeat operations.

3.1.1.11 Stops the indicator. (1)

(Appendix continued on next page)

APPENDIX C (Continued)

3.1.2 Associates operation of external controls with functional sections.

2.2 Visually inspects the AN/SPA-34 for damaged components, cracked or frayed insulation, and loose connections. (1)

*3.3 Measures input-output signal characteristics of each functional section, locating test points, and using appropriate test equipment, following TM procedures and safety precautions and compares them with the theoretical. (2)

3.3.1 Performs 3.3 for the POWER SUPPLIES.

3.3.2 Performs 3.3 for the SWEEP GATE GENERATOR function. (1)

3.3.3 Performs 3.3 for the CURSOR GATE GENERATOR function. (1)

3.3.4 Performs 3.3 for the RANGE RING GENERATOR function. (1)

3.3.5 Performs 3.3 for the RANGE STROBE SERVO AMPLIFIER function. (1)

3.3.6 Performs 3.3 for the RANGE STROBE SERVO GENERATOR function. (1)

3.3.7 Performs 3.3 for OFF-CENTERING AMPLIFIER function. (1)

3.3.8 Performs 3.3 for MANUAL-DRA OFF-CENTERING function. (1)

3.3.9 Performs 3.3 for the AEW OFF-CENTERING function. (1)

3.3.10 Performs 3.3 for the CURSOR ORIGIN JOYSTICK OFF-CENTERING function. (1)

3.3.11 Performs 3.3 for the ANTENNA BEARING SERVO AMPLIFIER function. (1)

3.3.12 Performs 3.3 for the SWEEP GENERATOR function. (1)

3.3.13 Performs 3.3 for the SWEEP AMPLIFIER function. (1)

3.3.14 Performs 3.3 for the VIDEO UNBLANKING AMPLIFIER function. (1)

4.0 Locates source of malfunctions in the AN/SPA-34. (2)

*4.1 Isolates a malfunction in the AN/SPA-34 to a functional section, following all safety precautions using the overall functional block diagram, applicable test equipment, and logical troubleshooting procedures. (1)

(Appendix continued on next page)

*4.2** Isolates a malfunction within a function of the AN/SPA-34 locating test points and components, following safety precautions, using logical troubleshooting procedures, the schematic diagrams, and appropriate test equipment. (2)

4.2.1 Performs 4.2 for SWEEP GATE GENERATOR malfunction. (2)

4.2.1.1 Removes and replaces the SWEEP GATE GENERATOR BOARDS (1A1, 1A2, and 1A4). (1)

4.2.1.2 Recognizes need for alignment of the SWEEP GATE GENERATOR. (1)

4.2.2 Performs 4.2 for CURSOR GATE GENERATOR malfunction. (2)

4.2.3 Performs 4.2 for RANGE RING GENERATOR malfunction. (2)

4.2.3.1 Recognizes need for alignment of the RANGE RING GENERATOR. (1)

4.2.4 Performs 4.2 for RANGE STROBE SERVO AMPLIFIER malfunction. (2)

4.2.4.1 Recognizes need for adjusting the RANGE STROBE DRIVE. (1)

4.2.5 Performs 4.2 for RANGE STROBE GENERATOR malfunction. (2)

4.2.5.1 Recognizes need for alignment of RANGE STROBE GENERATOR. (1)

4.2.6 Performs 4.2 for OFF-CENTERING AMPLIFIER malfunction. (2)

4.2.7 Performs 4.2 for MANUAL-DRA OFF-CENTERING function. (2)

4.2.7.1 Recognizes need for alignment of the MANUAL OFF-CENTERING function. (1)

4.2.8 Performs 4.2 for AEW OFF-CENTERING malfunction. (2)

4.2.8.1 Recognizes need for alignment of the AEW function. (1)

4.2.9 Performs 4.2 for CURSOR ORIGIN JOYSTICK OFF-CENTERING malfunction. (2)

4.2.9.1 Recognizes need for CURSOR ORIGIN JOYSTICK alignment. (1)

4.2.10 Performs 4.2 for ANTENNA BEARING SERVO AMPLIFIER malfunction. (2)

**Only complex fourth level tasks identified under 4.2.

(Appendix continued on next page)

APPENDIX C (Continued)

4.2.10.1 Recognizes need for alignment of ANTENNA BEARING SYNCHROS. (1)

4.2.11 Performs 4.2 for SWEEP GENERATOR function. (2)

4.2.11.1 Recognizes need for removing assemblies in SWEEP GENERATOR. (1)

4.2.11.2 Recognizes need for alignment of the VIDEO and CURSOR SWEEP BALANCE. (1)

4.2.11.3 Recognizes need to perform the STEP AMPLITUDE adjustment. (1)

4.2.11.4 Recognizes need to perform the VIDEO and CURSOR SWEEP GAIN and TRACKING adjustment. (1)

4.2.11.5 Removes and replaces assemblies in SWEEP GENERATOR. (1)

4.2.12 Performs 4.2 for SWEEP AMPLIFIER malfunction. (2)

4.2.12.1 Recognizes need for alignment of the VIDEO SWEEP ORIGIN. (1)

4.2.12.2 Recognizes need to perform the VIDEO SWEEP CENTERING and LEVELING adjustment. (1)

4.2.12.3 Recognizes need for alignment of the OFF-CENTERING TRACKING. (1)

4.2.13 Performs 4.2 for the VIDEO and UNBLANKING AMPLIFIER malfunction. (2)

5.0 Performs maintenance actions. (2)

5.1 Replaces damaged components, cracked or frayed insulation. (1)

5.2 Replaces or repairs printed circuit boards. (1)

5.3 Solders loose connections. (1)

*5.4 Aligns and adjusts circuitry and assemblies. (2)

5.4.1 Aligns the SWEEP GATE GENERATOR. (2)

5.4.2 Aligns the RANGE RING alignment. (2)

5.4.3 Performs the RANGE STROBE DRIVE adjustment. (2)

5.4.4 Aligns the RANGE STROBE GENERATOR. (2)

5.4.5 Aligns the MANUAL OFF-CENTERING function. (2)

(Appendix continued on next page)

5.4.6 Aligns the AEW OFF-CENTERING function. (2)

5.4.7 Aligns the CURSOR ORIGIN JOYSTICK. (2)

5.4.8 Aligns ANTENNA BEARING SYNCHROS. (2)

5.4.9 Removes and replaces assemblies in the SWEEP GENERATOR.

5.4.10 Aligns VIDEO and CURSOR SWEEP BALANCE. (2)

5.4.11 Performs the STEP AMPLITUDE adjustment. (2)

5.4.12 Performs the VIDEO and CURSOR SWEEP GAIN and TRACKING adjustment. (2)

5.4.13 Aligns VIDEO SWEEP ORIGIN. (2)

5.4.14 Performs the VIDEO SWEEP CENTERING and LEVELING adjustments. (2)

5.4.15 Aligns the OFF-CENTERING TRACKING. (2)

6.0 Documents AN/SPA-34 maintenance actions in accordance with 3M Manual, OPNAV 43P2. (1)

*6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

7.0 Performs equipment associated job tasks. (1)

*7.1 Briefs operators on basic characteristics and accuracy of AN/SPA-34 repeater. (1)

APPENDIX D

BASIC CURRICULUM OUTLINE FOR AN ELECTRONIC EQUIPMENT MAINTENANCE COURSE
AN/SPA-34

Basic Concepts of the AN/SPA-34

SHIPBOARD TASK: *1.0	Extracts information from the Technical Manual (TM) and/or Maintenance Requirement Cards (MRCs) required to operate the AN/SPA-34, perform and document maintenance actions.
SHIPBOARD TASK: 1.1	Extracts information from the schematics, general and detailed.
SHIPBOARD TASK: 1.2	Extracts information from the text.
SHIPBOARD TASK: 1.3	Extracts information from the tables.
SHIPBOARD TASK: *7.1	Briefs shipboard operator on the basic characteristics and accuracy of the AN/SPA-34 repeater.
SHIPBOARD TASK: Consolidation of part of 3.3 and 4.2	Locates major physical components and test points at the functional level.
Training Task 1:	After demonstration by instructor, of the physical equipment, including identification and location of test points and components, student, given an unlabeled schematic, identifies them with the aid of the TM.
Standards:	100% accuracy.
Training Task 2:	Locates a representative selection of information in each of the seven sections of the Technical Manual for Indicator Group AN/SPA-34 and AN/SPA-71.
Standards:	No error.
Training Task 3:	Given photographs of the AN/SPA-34 with outer coverings removed, labels major components.
Standards:	a. With the TM, no error. b. On real equipment, identifies major components with no error at request of the instructor.

(Appendix continued on next page)

Training Task 4: Identifies in writing on detailed schematics of a sample of AN/SPA-34 functional sections, the standard electrical/electronic symbols.

Standards: No error.

Training Task 5: Given an unlabeled schematic of a functional section diagram, labels each and writes a brief description of its function; describes normal use of AN/SPA-34 and lists major parameters and tolerances. May use Technical Manual.

Standards: No error.

Training Task 6: Briefs instructor, covering points in Training Task 5 that are essential to communicate to the operator. Instructor uses standard checklist of topics to be covered and notes any error or omission.

Standards: After initial instruction: errors and omissions permitted so long as no fundamentally wrong material presented. At end of course: no errors, no unnecessary information, specifically none that reduces clarity of presentation, included.

<u>SHIPBOARD TASK</u>: 6.0 Documents AN/SPA-34 maintenance actions in accordance with 3M Manual, OPNAV 43P2.

<u>SHIPBOARD TASK</u>: *6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 7: Documents a sample of the maintenance actions required as the student troubleshoots during the course.

Standards:

a. After initial instruction, completes one OPNAV Form 4700-2B correctly.

b. After completing training in troubleshooting within each functional section, completes one OPNAV Form 4700-2B. This requirement continued until completes two successively within the time standard established by the instructor.

(Appendix continued on next page)

Operating the AN/SPA-34

<u>SHIPBOARD TASK</u>: 3.1.1.1 — <u>Locates controls</u> relying on their shape and position.

Training Task 8: Same as job task.

Standards:

a. Locates controls in dim light on simulated front panel in three successive trials with no error.

b. Locates controls on equipment at request of instructor. Each control identified correctly twice.

<u>SHIPBOARD TASK</u>: Consolidation of Tasks 3.1.1.2, 3.1.1.3, 3.1.1.11 — Performs preliminary settings, starts, and stops the indicator.

Training Task 9: On a simulated front panel with adjustable and accurately positioned controls, student follows procedures to accomplish the job task as directed by instructor.

Standards: Until instructor considers student ready to operate the real equipment.

Training Task 10: Same as Training Task 9 on real equipment.

Standards: Until student can do job task with no error.

<u>SHIPBOARD TASK</u>: 3.1.1.4 — Adjusts indicator to proper intensity; then focuses.

<u>SHIPBOARD TASK</u>: 3.1.1.5 — Discriminates between video signals and background noise.

<u>SHIPBOARD TASK</u>: 3.1.1.9 — Discriminates between centered and noncentered presentations.

Training Task 11: From a series of photographs representing good and poor displays of the conditions given in the job tasks, student discriminates between them.

Standards: 90% accuracy.

(Appendix continued on next page)

Training Task 12: Student corrects a series of poorly focused displays (some noisy). Instructor must be alert to prevent student from using too high an intensity.

Standards:
a. Three successive trials to point where instructor cannot improve display significantly.

b. Instructor observes that student maintains good focus and intensity during Training Tasks 9 and 11.

<u>SHIPBOARD TASK:</u> 3.1.1.6 Finds the range and bearing of a target from sweep origin.

Training Task 13: Finds range and bearing of target from sweep origin when it is located in each of the four quadrants and at ranges from 1000 yards to 250 miles.

Standards: Five successive trials with bearing plus or minus 2.5°, range less than 3% under 50 miles less than 4% over 50 miles.

<u>SHIPBOARD TASK:</u> 3.1.1.7 Finds range and bearing between targets.

Training Task 14: Finds range and bearing between targets.

Standards: Five successive trials with <u>bearing</u> within plus or minus 2.5°, <u>range</u> less than 4% under 50 miles, less than 4% over 50 miles.

<u>SHIPBOARD TASK:</u> 3.1.1.8 Performs close observation of a target.

Training Task 15: With target located at 325°, 180 miles expands target for close observation. Task must be performed from memory.

Standards: Five successive trials with target centrally located on the PPI with range control set at minimum.

<u>SHIPBOARD TASK:</u> 3.1.1.10 Performs AEW tracking and repeat operations.

Training Task 16: Performs job task on equipment from memory.

Standards: No error.

(Appendix continued on next page)

SHIPBOARD TASK: 3.1.1.1 — Locates controls, relying on shape and position of control knobs for their identification.

Training Task 17: In semidarkness, and as directed by the instructor, locates AN/SPA-34 controls on a simulated panel. (Controls are accurately shaped and placed.)

Standards: No errors in two successive series of trials involving all controls. As later training tasks are performed, instructor observes whether skill is retained.

Training Task 18: In semidarkness, and as directed by the instructor locates the AN/SPA-34 controls. Series planned to emphasize most common sequences used in instructor checks.

Standards: Locates each control correctly three times in a series of trials involving all controls. As later training tasks are performed, instructor notes whether this skill is retained.

SHIPBOARD TASK: 3.1.1 — Operates in semidarkness the AN/SPA-34 Indicator Group in all modes.

Training Task 19: With equipment functioning normally, instructor directs student to perform repeated cycles of job tasks, covering all modes of operation.

Standards: Exercise continued until student completes two cycles without error in procedure, while maintaining focus and intensity adjustment at a point where instructor cannot significantly improve.

SHIPBOARD TASK: 3.0 — Performs checks and tests, following all equipment and personnel safety precautions.

SHIPBOARD TASK: *3.1 — Performs indicator checks as an aid in locating a malfunction.

Training Task 20: Given pictures of indicator displays representing malfunctions, student identifies possible functional section location(s) of the malfunction, using the Technical Manual.

Standards: No error.

(Appendix continued on next page)

SHIPBOARD TASK: 3.1.2 — Associates operation of external controls with functional sections.

Training Task 21: Shown a series of instructor triggered displays, representing some normal but most abnormal, student identifies possible functional section location(s).

Standards: Exercise continues until student has associated correctly each possible malfunction display with its functional section(s) on a consecutive series of trials.

Test Equipment

SHIPBOARD TASK: 2.2 (includes 2.2.1-2.2.5) — Sets up, checks and operates the AN/PSM-4c multimeter to measure voltages, currents, and values of resistance.

Training Task 22: Same as job task but on a group of circuits prepared for efficient training. Exercise covers a good sample of measurements that will be required to troubleshoot the AN/SPA-34.

Standards: A series of ten measurements accurate within manufacturer's guarantee. Student not permitted to continue until he meets this criterion.

SHIPBOARD TASK: *2.1 (includes 2.1.1-2.1.8) — Sets up, checks operation, and operates the AN/USM-140c to measure amplitude and time interval of signal.

Training Task 23: Same as job task, using circuits designed for efficient learning of the operation of the AN/USM-140c.

Standards: Measurements within $\pm$ 1% of actual signal values for 10 consecutive trials. Student is not permitted to continue until he meets this criterion.

SHIPBOARD TASK: *2.3 — Sets up, checks, and operates the AN/USM-113 to (a) trigger the AN/SPA-34 and (b) measure RANGE RING accuracy.

Training Task 24: Same as job tasks (a) and (b).

Standards: No error in five consecutive trials.

(Appendix continued on next page)

APPENDIX D (Continued)

SHIPBOARD TASK: 3.3.1 — Performs 3.3 for POWER SUPPLIES.

Training Task 25: Trainee locates each of the POWER SUPPLIES supplying the various voltages and fills the following information into the blanks provided on the job sheets:

1. Type of rectification
2. Output voltage
3. Type of regulation
4. General use of the output
5. Circuit symbol designation of the adjustment control (if applicable)

Standards: No errors or omissions.

Training Task 26: Same as job task, with instructor inserted and maladjustments.

Standards: Adjusts voltages within output tolerances in three consecutive trials.

Soldering

SHIPBOARD TASK: 5.2 — Replaces or repairs printed circuit boards.

SHIPBOARD TASK: 5.3 — Solders loose connections.

Training Task 27: Connects loose wire on printed circuit boards by soldering, following procedure specified in the EIC Manual.

Standards: Soldered joint conducts current, stands a pull test, and meets the standards given in the EIC Manual.

SHIPBOARD TASK: *3.3 (includes 3.3.2-3.3.14) — Measures input-output signal characteristics of each functional section, locating test points, and using appropriate test equipment, following TM procedures and safety precautions and compares them with the theoretical.

(Appendix continued on next page)

Training Task 28: Student triggers AN/SPA-34 at a low REP rate with AN/USM-115 and using an AN/USM-140 oscilloscope, observes the wave forms at the functional sections input and output test points. He draws the actual wave forms on a schematic, referencing each to the proper point and labeling each as to amplitude and time. He repeats the exercise at a high REP rate.

Standards: Student continues measurement for any three functional sections until drawings are a close approximation of the wave shape and measurements within 10% of actual value.

SHIPBOARD TASK: *4.1 Isolates a malfunction in the AN/SPA-34 to a functional section, following all safety precautions using the overall functional block diagram, applicable test equipment, and logical troubleshooting procedures.

Training Task 29: Student analyzes instructor inserted malfunction from front panel indications and determines faulty functional block/blocks. He then verifies his determination by selecting the appropriate test equipment and monitoring inputs and outputs of the suspected functional block. This process is repeated until he has been exposed to malfunctions in each functional area. Exercise includes trials with no malfunctions and emphasized interrelationships of functional sections.

Standards: Student must develop 100% accuracy in a series of trials involving all functional sections before proceeding further.

Malfunctions Within Functional Sections: SWEEP GATE GENERATOR

SHIPBOARD TASK: *4.2 Isolates a malfunction within a function of the AN/SPA-34 locating test points and components following safety precautions, using logical troubleshooting procedures, the schematic diagrams, and appropriate test equipment.

'BOARD TASK: .1 Performs 4.2 for SWEEP GATE GENERATOR malfunction.

SHIPBOARD TASK: *5.4 Aligns and adjusts circuitry and assemblies.

(Appendix continued on next page)

SHIPBOARD TASK: 4.2.1.1 — Removes and replaces the SWEEP GATE GENERATOR BOARDS (1A1, 1A2, and 1A4).

SHIPBOARD TASK: 4.2.1.2 — Recognizes need for alignment of the SWEEP GATE GENERATOR.

SHIPBOARD TASK: 5.4.1 — Aligns the SWEEP GATE GENERATOR.

Training Task 30: Given an unlabeled schematic of the circuitry within the SWEEP GATE GENERATOR, locates assemblies, test points, labels circuits as to function. Does this with aid of Technical Manual.

Standards: No error.

Training Task 31: Identifies and locates assemblies, components, and test points on equipment while explaining the operation of SWEEP GATE GENERATOR using the schematic diagram (Figure 4-3) in the Technical Manual. Explanation will include:

a. the pulse width, amplitude, pulse repetition frequency, and wave shape of the signals at the inputs, test points, and outputs;
b. the function of the circuits;
c. the output signal distribution; and
d. the circuit theory of the Schmitt Trigger.

Standards: No location or identification error. No error of practical significance in explanation.

SHIPBOARD TASK: 4.2.1.1 — Remove and replace SWEEP GATE GENERATOR boards: (1A1, 1A2, and 1A4).

Training Task 32: Same as job task.

Standards: Printed circuit boards are inserted correctly in the EXTENDER BOARD.

(Appendix continued on next page)

Training Task 33: With an instructor inserted malfunction, trainee will verify that the malfunction is in the SWEEP GATE GENERATOR by front panel indications and then by monitoring the input and output wave forms of the functional block. The student will then troubleshoot the SWEEP GATE GENERATOR to the stage level using logical problem solving techniques. He may use any of the supplied test equipment, the Technical Manual, and class notes. Twenty-five percent of the inserted malfunctions will be located in other functional sections. These inserted malfunctions will predominantly involve consideration of the interrelationship among functional sections. These will be located to functional block/blocks only. Malfunctions inserted will cover all components and circuit types but will emphasize those most characteristic of shipboard failures.

Standards: Exercise will continue until student has located three successive malfunctions in the SWEEP GATE GENERATOR within the time given on the performance evaluation sheet and until at least five malfunctions are successively located to other functional sections.

Training Task 34: With 50% of the controls in the SWEEP GATE GENERATOR slightly misaligned and/or misadjusted to simulate a normal requirement for alignment, the student, using the AN/USM-115 as a trigger generator, performs the alignment following the procedure in the Technical Manual.

Standards: Alignment will be considered satisfactory if retrace time and sweep gate length comply with Technical Manual specification. Exercise continues until student can reach the standard on two of three consecutive trials.

Malfunctions Within the CURSOR GATE GENERATOR

<u>SHIPBOARD TASK:</u> 4.2.2 Performs 4.2 for CURSOR GATE GENERATOR malfunction.

Training Task 35: Given an unlabeled schematic of the circuitry within the CURSOR GATE GENERATOR, locates assemblies, test points, labels circuits as to function. Does this with the aid of Technical Manual.

(Appendix continued on next page)

Standards: No error:

Training Task 36: Identifies and locates assemblies, components, and test points on equipment while explaining the operation of the CURSOR GATE GENERATOR using the schematic diagram (Figure 5-7) in the Technical Manual. Explanation will include:

a. the pulse width, amplitude, pulse repetition frequency, and wave shape of the signals at the inputs, test points and outputs;
b. the function of the circuits; and
c. the output signal distribution.

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 37: Same as Training Task 33 for the CURSOR GATE GENERATOR.

Standards: Same as for Training Task 33.

<u>SHIPBOARD TASK:</u> *6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 38: Same as job task for one of the maintenance actions that would be required.

Standards: No error.

Malfunctions Within the SWEEP GENERATOR

<u>SHIPBOARD TASK:</u> 4.2.11 Performs 4.2 for SWEEP GENERATOR function.

<u>SHIPBOARD TASK:</u> 4.2.11.1 Recognizes need for removing assemblies in SWEEP GENERATOR.

<u>SHIPBOARD TASK:</u> 5.4.9 Removes and replaces assemblies in SWEEP GENERATOR.

<u>SHIPBOARD TASK:</u> 4.2.11.2 Recognizes need for alignment of the VIDEO and CURSOR SWEEP BALANCE.

(Appendix continued on next page)

SHIPBOARD TASK: 5.4.10 — Aligns VIDEO and CURSOR SWEEP BALANCE.

SHIPBOARD TASK: 4.2.11.3 — Recognizes need to perform the STEP AMPLITUDE adjustment.

SHIPBOARD TASK: 5.4.11 — Performs the STEP AMPLITUDE adjustment.

SHIPBOARD TASK: 4.2.11.4 — Recognizes need to perform the VIDEO and CURSOR SWEEP GAIN and TRACKING adjustment.

SHIPBOARD TASK: 5.4.12 — Performs the VIDEO and CURSOR SWEEP GAIN and TRACKING adjustment.

SHIPBOARD TASK: 4.2.11.5 — Removes and replaces assemblies in SWEEP GENERATOR.

Training Task 39: Given an unlabeled schematic of the circuitry within the SWEEP GENERATOR, locates assemblies, test points, labels circuits as to function. Does this with the aid of Technical Manual.

Standards: No error of practical significance in the drawing from memory.

Training Task 40: Identifies and locates assemblies, test points or equipment while explaining the operation of the SWEEP GENERATOR using the schematic diagram (Figure 4-30) in the Technical Manual. Explanation will include:

a. the amplitude, wave shape and pulse repetition frequency of the "Sweep Gate" and "Cursor Gate" inputs;
b. the amplitude and polarity of the "Cursor Bearing," "Antenna Bearing," and "DC Azimuth" inputs;
c. the amplitude, polarity, frequency, wave shape and pulse repetition frequency of signals at the test points;
d. amplitude, polarity, and pulse repetition frequency of "sweep" and "steps" outputs;
e. function of the circuits;
f. relay functions;
g. circuit theory of the "Constant Current Generators"; and
h. output signal distribution.

(Appendix continued on next page)

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 41: Removes and replaces assemblies in the SWEEP GENERATOR.

Standards: No error.

Training Task 42: Same as Training Task 33 for the SWEEP GENERATOR.

Standards: Same as for Training Task 33.

Training Task 43: Same as Training Task 34 for the VIDEO and CURSOR SWEEP BALANCE alignment.

Standards: Alignment will be considered satisfactory if a spot appears in the center of the CRT with NORM-ALIGN switch in the "ALIGN" position.

Training Task 44: Same as Training Task 34 for the STEP AMPLITUDE adjustment.

Standards: Adjustment will be considered satisfactory if the cursor is straight at all bearings.

Training Task 45: Same as Training Task 34 for the VIDEO and CURSOR SWEEP GAIN and TRACKING adjustment.

Standards: Adjustment will be considered satisfactory when the range marks on the video and cursor sweeps are in coincidence at all settings of the range selector.

SHIPBOARD TASK: *6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 46: Same as job task for one of the maintenance that would be required.

Standards: No error.

(Appendix continued on next page)

Malfunctions within
the SWEEP AMPLIFIER

SHIPBOARD TASK: 4.2.12 — Performs 4.2 for SWEEP AMPLIFIER malfunction.

SHIPBOARD TASK: 4.2.12.1 — Recognizes need for alignment of the VIDEO SWEEP ORIGIN.

SHIPBOARD TASK: 5.4.13 — Aligns the VIDEO SWEEP ORIGIN, following the procedures given in the Technical Manual.

SHIPBOARD TASK: 4.2.12.2 — Recognizes need to perform VIDEO SWEEP CENTERING and LEVELING adjustment.

SHIPBOARD TASK: 5.4.14 — Performs the VIDEO SWEEP CENTERING and LEVELING.

SHIPBOARD TASK: 4.2.12.3 — Recognizes need for alignment of the OFF-CENTERING TRACKING.

SHIPBOARD TASK: 5.4.15 — Aligns OFF-CENTERING TRACKING adjustment.

Training Task 47: Given an unlabeled schematic of the circuitry within the SWEEP AMPLIFIER, locates assemblies, test points, labels circuits as to function. Does this with aid of Technical Manual.

Standards: No error.

Training Task 48: Identifies and locates assemblies, components, and test points on equipment while explaining the operation of the SWEEP AMPLIFIER using the schematic diagram in the Technical Manual. Explanation will include:

a. the pulse width, amplitude, pulse repetition frequency, and wave shape of the signals at the inputs, test points, and outputs.

b. the amplitude and polarity of the D. C. "Off-Centering" inputs;

c. the function of the circuits;

d. the output signal distribution; and

e. the function of all relays.

(Appendix continued on next page)

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 49: Same as Training Task 33 for SWEEP AMPLIFIER.

Standards: Same as for Training Task 33.

Training Task 50: Same as Training Task 34 for the VIDEO SWEEP ORIGIN alignment.

Standards: Alignment will be considered satisfactory if sweep origin does not shift position when changing from "cursor centered" to "cursor off-centered."

Training Task 51: Same as Training Task 34 for the VIDEO SWEEP CENTERING and LEVELING adjustments.

Standards: Adjustment will be considered satisfactory if the sweep is straight and centered upon completion of the exercise.

Training Task 52: Same as Training Task 34 for the OFF-CENTERING TRACKING alignment.

Standards: Alignment will be considered satisfactory if when in the "Off-Center Function" the position of the range strobe does not change when the "Range Selector" is on.

<u>SHIPBOARD TASK</u>: *6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 53: Same as job task for one maintenance action that would be required.

Standards: No error.

Malfunction within OFF-CENTERING

<u>SHIPBOARD TASK</u>: A consolidation of 4.2.6, 4.2.7, 4.2.8, and 4.2.9 Isolates a malfunction within the OFF-CENTERING of the AN/SPA-34 locating test points and components following safety precautions, using logical troubleshooting procedures, the schematic diagrams, and appropriate test equipment.

(Appendix continued on next page)

APPENDIX D (Continued)

SHIPBOARD TASK: 4.2.7.1 — Recognizes need for alignment of the MANUAL OFF-CENTERING function.

SHIPBOARD TASK: 5.4.5 — Aligns the MANUAL OFF-CENTERING function.

SHIPBOARD TASK: 4.2.8.1 — Recognizes need for alignment of the AEW function.

SHIPBOARD TASK: 5.4.6 — Aligns the AEW OFF-CENTERING function.

SHIPBOARD TASK: 4.2.9.1 — Recognizes need for CURSOR ORIGIN JOYSTICK alignment.

SHIPBOARD TASK: 5.4.7 — Aligns the CURSOR ORIGIN JOYSTICK.

Training Task 54: Given an unlabeled schematic of the circuitry within the OFF-CENTERING AMPLIFIER, locates assemblies, test points, labels circuits as to function. Does this with the aid of Technical Manual.

Standards: No error.

Training Task 55: Identifies and locates assemblies, components, and test points on equipment while explaining the operation of the OFF-CENTERING AMPLIFIER using the schematic diagram (Figure 5-16) in the Technical Manual. Explanation will include:

a. the polarity and amplitude of the signals at the inputs, test points, and outputs;

b. the function of the circuits; and

c. the output signal distribution.

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 56: Same as Training Task 33 for the OFF-CENTERING AMPLIFIER.

Standards: Same as for Training Task 33.

(Appendix continued on next page)

APPENDIX D (Continued)

Training
Task 57: Same as Training Task 33 for the MANUAL-DRA OFF CENTERING function.

Standards: Same as for Training Task 33.

Training
Task 58: Same as Training Task 33 for the AEW OFF-CENTERING function.

Standards: Same as for Training Task 33.

Training
Task 59: Same as Training Task 33 for the OFF-CENTERING function.

Standards: Same as for Training Task 33.

Training
Task 60: Same as Training Task 34 for the MANUAL OFF-CENTERING alignment.

Standards: Alignment will be considered satisfactory if MAN/DRA counter readings coincide with the actual amount of off-centering.

Training
Task 61: Same as Training Task 34 for the AEW OFF-CENTERING alignment.

Standards: Alignment will be considered satisfactory if the AEW counter readings coincide with the actual amount of off-centering.

Training
Task 62: Same as Training Task 34 for the CURSOR ORIGIN JOYSTICK alignment.

Standards: The alignment will be considered satisfactory if the cursor origin does not shift at the range selector point.

SHIPBOARD TASK:
*6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training
Task 63: Same as job task for one maintenance function that would be required.

Standards: No error.

(Appendix continued on next page)

Malfunction Within
RANGE RING GENERATOR

SHIPBOARD TASK: 4.2.3 — Performs 4.2 for RANGE RING GENERATOR malfunction.

SHIPBOARD TASK: 4.2.3.1 — Recognizes need for alignment of the RANGE RING GENERATOR.

SHIPBOARD TASK: 5.4.2 — Aligns the RANGE RING.

Training Task 64: Given an unlabeled schematic of the circuitry within the RANGE RING GENERATOR, locates assemblies, test points, labels circuits as to function. Does this with the aid of Technical Manual.

Standards: No error.

Training Task 65: Identifies and locates assemblies, components and test points on equipment while explaining operation of the RANGE RING GENERATOR using the schematic diagram (Figure 4-11) in the Technical Manual. Explanation will include:

a. the pulse width, amplitude, pulse repetition frequency and wave shape of the signals at the inputs, test points, and outputs;

b. the function of the circuits; and

c. the output signal distribution.

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 66: Same as Training Task 33 for the RANGE RING GENERATOR.

Standards: Same as for Training Task 33.

Training Task 67: Tests RANGE RING accuracy using the AN/USM-115 RANGE CALIBRATOR SET following procedures in the TM.

Standards: Must be able to determine when alignment is required.

(Appendix continued on next page)

Training Task 68: Same as Training Task 34 for the RANGE RING GENERATOR alignment.

Standards: Alignment will be considered satisfactory when standards detailed on the Maintenance Requirement Cards are met.

<u>SHIPBOARD TASK:</u> *6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 69: Same as job task for one of the maintenance tasks that would be required.

Standards: No error.

Malfunctions Within RANGE STROBE GENERATOR

<u>SHIPBOARD TASK:</u> 4.2.5 Performs 4.2 for RANGE STROBE GENERATOR malfunction.

<u>SHIPBOARD TASK:</u> 4.2.5.1 Recognizes need for alignment of RANGE STROBE GENERATOR.

<u>SHIPBOARD TASK:</u> 5.4.4 Aligns the RANGE STROBE GENERATOR.

Training Task 70: Given an unlabeled schematic of the circuitry within the RANGE STROBE GENERATOR locates assemblies, test points, labels circuits as to function. Does this with the aid of Technical Manual.

Standards: No error.

Training Task 71: Identifies and locates assemblies, components, and test points on equipment while explaining operation of the RANGE STROBE GENERATOR using the schematic (Figure 4-17) of the Technical Manual. Explanation will include:

a. the pulse width, amplitude, pulse repetition frequency, and wave shape of the signals at the inputs, test points, and output;

b. the function of the circuits;

(Appendix continued on next page)

c. the output signal distribution; and

d. the function of the relays.

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 72: Same as Training Task 33 for the RANGE STROBE GENERATOR.

Standards: Same as for Training Task 33.

Training Task 73: Same as Training Task 34 for the RANGE STROBE GENERATOR alignment.

Standards: Alignment will be considered satisfactory when the standards detailed on the Maintenance Requirement Card are met. "Range Strobe" range must coincide with the "Range Rings."

SHIPBOARD TASK: *6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 74: Same as job task for one maintenance action that would be required.

Standards: No error.

Malfunctions Within RANGE STROBE SERVO GENERATOR

SHIPBOARD TASK: 4.2.4 Performs 4.2 for RANGE STROBE SERVO AMPLIFIER malfunction.

SHIPBOARD TASK: 4.2.4.1 Recognizes need for adjusting the RANGE STROBE DRIVE.

SHIPBOARD TASK: 5.4.3 Performs the RANGE STROBE DRIVE adjustment.

Training Task 75: Given an unlabeled schematic of the circuitry within the RANGE STROBE SERVO AMPLIFIER, locates assemblies, test points, labels circuits as to function. Does this with aid of Technical Manual.

(Appendix continued on next page)

Standards: No error.

Training Task 76: Identifies and locates assemblies, components, and test points in equipment while explaining operation of the RANGE STROBE SERVO AMPLIFIER using the schematic diagram (Figure 4-15) in the Technical Manual. Explanation will include:

a. the amplitude and polarity of the signals at the input, test points, and outputs;

b. the function of the circuits; and

c. the signal output distribution.

Standards: No location or identification error. No error of practical significance in explanation.

Malfunctions Within the VIDEO and UNBALANCING AMPLIFIER

SHIPBOARD TASK: 4.2.13 — Performs 4.2 for the VIDEO and UNBLANKING AMPLIFIER malfunction.

Training Task 77: Same as Training Task 33 for the RANGE STROBE SERVO AMPLIFIER.

Standards: Same as for Training Task 33.

Training Task 78: Same as Training Task 34 for the RANGE STROBE DRIVE adjustment.

Standards: Alignment will be considered satisfactory if the range strobe travels from 0 to 400 miles in course operation in less than 5 seconds and the gears do not chatter with the strobe at rest.

SHIPBOARD TASK: *6.1 — Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 79: Same as job task for one of the maintenance actions required.

(Appendix continued on next page)

Standards: No error.

Training Task 80: Given an unlabeled schematic of the circuitry within the VIDEO and UNBLANKING AMPLIFIER, locates assemblies, test points, labeling circuits as to function. Does this with the aid of the Technical Manual.

Standards: No error.

Training Task 81: Identifies and locates assemblies, components, and test points on equipment while explaining operation of the VIDEO and UNBLANKING AMPLIFIER using the schematic diagram (Figure 4-37) in the Technical Manual. Explanation will include:

a. the pulse width, amplitude, pulse repetition frequency and wave shape of the signals at the inputs, test points, and output;

b. the function of the circuits; and

c. the output signal distribution.

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 82: Same as Training Task 33 for VIDEO and UNBLANKING AMPLIFIER.

Standards: Same as for Training Task 33.

<u>SHIPBOARD TASK:</u> *6.1 Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.

Training Task 83: Same as job task for one of the maintenance that would be required.

Standards: No error.

(Appendix continued on next page)

Malfunctions Within the ANTENNA BEARING SERVO AMPLIFIER

SHIPBOARD TASK: 4.2.10	Performs 4.2 for ANTENNA BEARING SERVO AMPLIFIER malfunction.
SHIPBOARD TASK: 4.2.10.1	Recognizes need for alignment of ANTENNA BEARING SYNCHROS.
SHIPBOARD TASK: 5.4.8	Aligns ANTENNA BEARING SYNCHROS.

Training Task 84: Given an unlabeled schematic of the circuitry within the ANTENNA BEARING SERVO AMPLIFIER locating assemblies, test points, labeling circuits as to function. Does this with the aid of Technical Manual.

Standards: No error.

Training Task 85: Identifies and locates assemblies, components and test points on the operation of the ANTENNA BEARING SERVO AMPLIFIER using the schematic diagram (Figure 4-28) in the Technical Manual. Explanation will include:

a. the amplitude of signals at the inputs, test points, and outputs;

b. the function of the circuits; and

c. the output signal distribution.

Standards: No location or identification error. No error of practical significance in explanation.

Training Task 86: Same as Training Task 33 for ANTENNA BEARING AMPLIFIER.

Standards: Same as for Training Task 33.

Training Task 87: Same as Training Task 34 for ANTENNA BEARING SYNCHROS alignment.

Standards: Repeater bearing error must be less than 1° upon completion of the alignment.

(Appendix continued on next page)

SHIPBOARD TASK: *6.1	Completes OPNAV Form 4700-2B for each maintenance performed, except those performed for daily and weekly maintenance.
Training Task 88:	Same as job task for one of the maintenance actions that would be required.
Standards:	No error; with time standard set by instructor.

APPENDIX E

Task Inventory for TIG Welding Plate

4.0	TIG WELDS
4.1	TIG welds plate
4.1.1	Identifies parameters of system to be welded.
4.1.2	Identifies, assembles, and energizes TIG inert gases and equipment.
4.1.3	Performs routine maintenance on TIG welding equipment.
4.1.4	Identifies and uses TIG protective equipment.
4.1.5	Uses and interprets TIG welding reference manuals.
4.1.6	Identifies base metals and filler metals commonly used in TIG welding and relates applicable filler metals to base metals.
4.1.7	Constructs mock-ups and assembles joints for TIG welding.
4.1.8	Prepares surfaces to be welded.
4.1.9	Tack welds using TIG process.
4.1.10	Fusion welds using TIG process.
4.1.11	TIG welds a pass using appropriate filler material.
4.1.11.1	Cleans TIG pass using stainless steel wire brush.
4.1.12	Recognizes and repairs visible defects in a TIG welded joint.
4.1.13	Establishes an acceptable, final surface condition.
*4.2	TIG welds aluminum plate.
4.1.3.2	Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on aluminum for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.
4.1.1.2	Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding ruptured seams in aluminum for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.2.2 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding cracks in aluminum for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.4.1.1 Repairs pump impellers by TIG welding cracks on aluminum for acceptance in accordance with MIL-STD 278.

4.4.2.1 Builds up pump impellers by TIG welding eroded areas on aluminum for acceptance in accordance with MIL-STD 278.

4.5.2.1 Repairs pump housings by TIG welding cracks in aluminum for acceptance in accordance with MIL-STD 278.

4.5.1.2 Builds up pump housings by TIG welding eroded areas on aluminum for acceptance in accordance with MIL-STD 278.

4.7.1.1 Repairs machinery guards by TIG welding tee joints on aluminum for acceptance in accordance with MIL-STD 278.

4.7.2.1 Repairs machinery guards by TIG welding butt joints on aluminum for acceptance in accordance with MIL-STD 278.

4.7.3.1 Repairs machinery guards by TIG welding cracks in aluminum for acceptance in accordance with MIL-STD 278.

*4.3 TIG welds carbon steel plate.

4.1.1.1 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding ruptured seams in carbon steel for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.2.1 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding cracks in carbon steel for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.3.1 Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on carbon steel for acceptance in accordance with MIL-STD 278.

*4.4 TIG welds CRES plate.

4.1.3.3 Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on CRES for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.1.3 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding ruptured seams in CRES for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.2.3 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding cracks in CRES for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.2.1.1 Repairs brine tanks and hagevap tanks by TIG welding ruptured seams in CRES for acceptance in accordance with MIL-STD 278.

4.2.2.1 Repairs brine tanks and hagevap tanks by TIG welding cracks in CRES for acceptance in accordance with MIL-STD 278.

4.3.1.1 Repairs pump wearing rings by TIG welding cracks on cast CRES for acceptance in accordance with MIL-STD 278.

4.3.2.1 Builds up pump wearing rings by TIG welding worn areas on cast CRES for acceptance in accordance with MIL-STD 278.

4.4.2.2 Builds up pump impellers by TIG welding eroded areas on CRES for acceptance in accordance with MIL-STD 278.

4.5.1.3 Repairs pump housings by TIG welding cracks in CRES for acceptance in accordance with MIL-STD 278.

4.5.2.3 Builds up pump housings by TIG welding eroded areas on CRES for acceptance in accordance with MIL-STD 278.

4.6.1.1 Repairs strainer baskets by TIG welding lap joints on CRES for acceptance in accordance with MIL-STD 278.

4.6.2.1 Repairs strainer baskets by TIG welding butt joints on CRES for acceptance in accordance with MIL-STD 278.

4.6.3.1 Repairs strainer baskets by TIG welding cracks on CRES material for acceptance in accordance with MIL-STD 278.

*4.5 TIG welds monel plate.

4.5.1.1 Repairs pump housings by TIG welding cracks in monel for acceptance in accordance with MIL-STD 278.

4.5.2.1 Builds up pump housings by TIG welding eroded areas on monel for acceptance in accordance with MIL-STD 278.

*4.6	TIG welds bronze plate.
4.9.1.1	Repairs valve bodies by TIG welding cracks in bronze for acceptance in accordance with MIL-STD 278.
4.10.1.1	Replace valve seats by TIG welding brass valve seats to a bronze valve body in accordance with MIL-STD 278.
4.7	Hardfaces using TIG welding
4.8.1.1	Repairs throttle valve seats by hardfacing (with a TIG welding technique) on an iron casting for acceptance in accordance with MIL-STD 278.
4.8.1.2	Repairs throttle valve seats by hardfacing (with a TIG welding technique) on a steel casting for acceptance in accordance with MIL-STD 278.

APPENDIX F

BASIC CURRICULUM OUTLINE FOR TIG WELDING PLATE

SKILL TASK: 4.1.1 — Identifies parameters of system to be welded (steam, firemain, structure)

Training Task 1: Relates system parameters to procedures in preparing for TIG welding, accomplishing the weld and reporting its completion by answering orally instructor's questions asked at irregular intervals during the course.

Standard: 100% accuracy by course end.

SKILL TASK: 4.1.2 — Identifies, assembles, and energizes TIG inert gases and equipment.

Training Task 2: Identifies, assembles, and energizes TIG inert gases and equipment to conform with Naval Ships Technical Manual, Chapter 9920, Welding and Allied Processes.

Standard: Assembles and energizes TIG equipment with 100% accuracy.

SKILL TASK: 4.1.3 — Performs routine maintenance on TIG welding equipment.

Training Task 3: Performs maintenance on TIG welding equipment in accordance with the manufacturer's instruction manual.

Standard: Performs maintenance procedures once with 100% accuracy and, additionally, maintains TIG welding equipment in good working condition throughout course.

SKILL TASK: 4.1.4 — Identifies and uses TIG protective equipment.

Training Task 4: Identifies TIG protective equipment to conform with Naval Ships Technical Manual, Cahpter 9920, Welding and Allied Processes.

Standard: Identifies TIG protective equipment with 100% accuracy.

SKILL TASK:
4.1.5 Uses and interprets TIG welding reference manuals.

Training Task 5: Uses and interprets TIG welding reference manuals.

Standard: Locates and interprets selected TIG welding passages in reference manuals within three minutes and with 100% accuracy.

SKILL TASK:
4.1.6 Identifies base metals and filler materials commonly used in TIG welding and relates applicable filler material to base metals to be welded.

Training Task 6: Identifies base metals and filler materials commonly used in TIG welding and relates filler materials to base metals as indicated in Master Base Material/ Filler Material Tables I, II, and III.

Standard: Selects above with 100% accuracy.

SKILL TASK:
4.1.7 Constructs mock-ups and assembles joints for TIG welding.

Training Task 7: Identifies and assembles L-1 lap, T-1 tee, and B-5 butt joints for TIG welding.

Standard: Assembles each of the above joints with 100% accuracy.

SKILL TASK:
4.1.8 Prepares surfaces to be welded.

Training Task 8: Removes extraneous materials (e.g., paint, oxidizing compounds, etc.) from surface to be TIG welded.

Standard: Cleans above so that surfaces contain no visible extraneous material.

SKILL TASK:
4.1.9 Tack welds using TIG process.

Training Task 9: Tack welds, using TIG process, lap, tee, and butt joints.

Standard: Tack welds each of the above joints with no visible rejectable defects.

SKILL TASK: 4.1.10		Fusion welds using TIG process.
	Training Task 10:	Fusion welds base metals on L-1 lap joint using TIG process.
	Standard:	Manipulates TIG torch correctly to cause 100% fusion between base metals with no visible rejectable defects.
SKILL TASK: 4.1.11		TIG welds a pass using appropriate filler material.
	Training Task 11:	TIG welds a pass using appropriate filler material.
	Standard:	Welds ten successive passes each on lap, tee, or butt joints, achieving 100% fusion between base metals and filler materials with no visible rejectable defects.
SKILL TASK: 4.1.12		Recognizes and repairs visible defects in a TIG welded joint.
	Training Task 12:	Recognizes and repairs visible defects in a TIG welded joint.
	Standard:	Identifies visible defects on five joints with 100% accuracy and repairs the defects with no visible rejectable defects.
SKILL TASK: 4.1.13		Establishes an acceptable, final surface condition.
	Training Task 13:	Establishes an acceptable final surface condition on TIG welded joints by removing surface scale with hand or rotary wire brush.
	Standard:	Establishes an acceptable final surface condition on three successive joints with no visible rejectable defects.

TASK AREA: TIG WELDS ALUMINUM

JOB INCUMBENT TASKS: 4.1.3.2	Installs fittings on auxiliary fuel tanks (i.e., in boats) by TIG welding a fillet weld on aluminum for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.1.2 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding ruptured seams in aluminum for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.2.2 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding cracks in aluminum for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.4.1.1 Repairs pump impellers by TIG welding cracks on aluminum for acceptance in accordance with MIL-STD 278.

4.4.2.1 Builds up pump impellers by TIG welding eroded areas on aluminum for acceptance in accordance with MIL-STD 278.

4.5.2.1 Repairs pump housings by TIG welding cracks in aluminum for acceptance in accordance with MIL-STD 278.

4.5.2.2 Builds up pump housings by TIG welding eroded areas on aluminum for acceptance in accordance with MIL-STD 278.

4.7.1.1 Repairs machinery guards by TIG welding tee joints on aluminum for acceptance in accordance with MIL-STD 278.

4.7.2.1 Repairs machinery guards by TIG welding butt joints on aluminum for acceptance in accordance with MIL-STD 278.

4.7.3.1 Repairs machinery guards by TIG welding cracks in aluminum for acceptance in accordance with MIL-STD 278.

Training Task: TIG welds two 16-gauge aluminum plates with a T-1 joint in a flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

Training Task: TIG welds 16-gauge aluminum plates with a B-5 butt joint in a flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

<u>TASK AREA: TIG WELDS CARBON STEEL</u>

<u>JOB INCUMBENT TASKS:</u>

4.1.1.1 Repairs auxiliary fuel tanks (i.e., in boats) by TIG welding cracks in carbon steel for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.2.1 Repairs auxiliary fuel tanks (i.e., in boats) by TIG welding cracks in carbon steel for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.3.1 Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on carbon steel for acceptance in accordance with MIL-STD 278.

Training Task: TIG welds 16-gauge carbon steel plate in a tee joint in a flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

Training Task: TIG welds 16-gauge carbon steel plate with a B-5 butt joint in the flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

TASK AREA: TIG WELDS CRES

JOB INCUMBENT TASK:
4.1.3.3 Installs fittings on auxiliary fuel tanks (i.e., in boats) by TIG welding fillet welds on CRES for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

Training Task: TIG welds a tee joint in 16-gauge CRES plate in a flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

JOB INCUMBENT TASKS:
4.1.1.3 Repairs auxiliary fuel tanks (i.e., in boats) by TIG welding ruptured seams in CRES for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.1.2.3 Repairs auxiliary fuel tanks (i.e., in boats) by TIG welding cracks in CRES for acceptance in accordance with approved shipboard procedures and NAVSHIPS 0900-003-8000.

4.2.1.1 Repairs brine tanks and hagevap tanks by TIG welding ruptured seams in CRES for acceptance in accordance with MIL-STD 278.

4.2.2.1 Repairs brine tanks and hagevap tanks by TIG welding cracks in CRES for acceptance in accordance with MIL-STD 278.

4.3.1.1 Repairs pump wearing rings by TIG welding cracks in cast CRES for acceptance in accordance with MIL-STD 278.

4.5.1.3 Repairs pump housings by TIG welding cracks on CRES for acceptance in accordance with MIL-STD 278.

4.6.2.1 Repairs strainer baskets by TIG welding butt joints on CRES for acceptance in accordance with MIL-STD 278.

4.6.3.1 Repairs strainer baskets by TIG welding cracks in CRES for acceptance in accordance with MIL-STD 278.

Training Task: TIG welds 16-gauge CRES plates with a B-5 butt joint in the flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

TASK AREA: TIG WELDS MONEL

JOB INCUMBENT TASKS:

4.5.1.1 Repairs pump housings by TIG welding cracks in monel for acceptance in accordance with MIL-STD 278.

4.5.2.1 Builds up pump housings by TIG welding eroded areas on monel for acceptance in accordance with MIL-STD 278.

Training Task: TIG welds 16-gauge monel plate with a B-5 butt joint in a flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

TASK AREA: TIG WELDS BRONZE

JOB INCUMBENT TASKS:

4.9.1.1 Repairs valve bodies by TIG welding cracks in bronze for acceptance in accordance with MIL-STD 278.

4.10.1.1 Replaces valve seats by TIG welding brass valve seats to a bronze body for acceptance in accordance with MIL-STD 278.

Training Task: TIG welds 16-gauge brass plate with a B-5 butt joint in a flat position.

Standard: Passes NDT visual inspection with no rejectable defects.

APPENDIX G

TASK INVENTORY FOR WELDING ON BOARD NAVAL SHIPS

(Reproduced from Research Report SRR 70-5, September 1969)

WELDING TASK INVENTORY

1.0 SILVER BRAZE WELDING TASKS

1.1.1.1 Repairs Class P-3A High-pressure Oxygen, High-pressure Helium, High-pressure Air (3000 psi), Medium-pressure Air (600), and Hydraulic systems by sil-brazing copper pipe to a bronze casting with an insert socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.1.2 Repairs Class P-3A Lube Oil, Diesel Fuel, Freon, and Fixed CO_2 by sil-brazing copper pipe to a bronze casting with an insert socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.1.3 Repairs Class P-3A Fuel system by sil-brazing copper nickel pipe to a bronze casting with an insert socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.1.4 Repairs Class P-3A Lube Oil, Diesel Fuel, Freon, and Fixed CO_2 systems by sil-brazing steel pipe to a bronze casting with an insert socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.2.1 Repairs Class P-3A High-pressure Oxygen, High-pressure Helium, High-pressure Air (3000 psi), Medium-pressure Air (600 psi), and Hydraulic systems by sil-brazing copper pipe to a bronze casting with a face fed socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.2.2 Repairs Class P-3A Lube Oil, Diesel Fuel, Freon, and Fixed CO_2 systems by sil-brazing copper pipe to a bronze casting with a face fed socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.2.3 Repairs Class P-3A Fuel system by sil-brazing copper nickel pipe to a bronze casting with a face fed socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.2.4 Repairs Class P-3A Lube Oil, Diesel Fuel, Freon, and Fixed CO_2 systems by sil-brazing steel pipe to a bronze casting with a face fed socket for acceptance in accordance with NavShips 0900-001-7000.

1.1.3.1 Repairs Class P-3A Lube Oil, Diesel Fuel, Freon, Fuel, and Fixed CO_2 systems, by sil-brazing monel valve ring to a bronze casting to pass 150% hydrostatic test and a dye penetrant examination.

1.2.1.1 Repairs Class P-3B Fresh Water, Low-pressure Air (200 psi), Auxiliary Exhaust, and 50 psi Steam systems by sil-brazing copper pipe to a bronze casting with an insert socket for acceptance in accordance with NavShips 0900-001-7000.

1.2.1.2 Repairs Class P-3B Main Condensate, Fire Main, Flushing, Salt Water Cooling, Fresh Water, Main Circulating, Auxiliary Circulating, Fixed Foam, De-aerating Feed, and Main, Secondary and Gravity Drainage systems by sil-brazing copper nickel pipe to a bronze casting with an insert socket for acceptance in accordance with NavShips 0900-001-7000.

1.2.1.3 Repairs Class P-3B Fresh Water system by sil-brazing brass pipe to a bronze casting with an insert socket for acceptance in accordance with NavShips 0900-001-7000.

1.2.2.1 Repairs Class P-3B Fresh Water, Low-pressure Air (200 psi), Auxiliary Exhaust, 50 psi Steam by sil-brazing copper pipe to a bronze casting with a face fed socket for acceptance in accordance with NavShips 0900-001-7000.

1.2.2.2 Repairs Class P-3B Main Condensate, Fire Main, Flushing, Salt Water Cooling, Fresh Water, Main Circulating, Auxiliary Circulating, Fixed Foam, De-aerating Feed, and Main, Secondary, and Gravity Drainage systems by sil-brazing copper nickel pipe to a bronze casting with a face fed socket for acceptance in accordance with NavShips 0900-001-7000.

1.2.2.3 Repairs Class P-3B Fresh Water system by sil-brazing brass pipe to a bronze casting with a face fed socket for acceptance in accordance with NavShips 0900-001-7000.

1.2.3.1 Repairs Class P-3B Fire Main, Flushing, Salt Water Cooling, Fresh Water, Main Condensate, Boiler Feed, Auxiliary Exhaust, 50 psi Steam, Low-pressure Air (200 psi), Main Circulating, Auxiliary Circulating, Fixed Foam, De-aerating Feed, and Main, Secondary, and Gravity Drainage systems by sil-brazing monel valve rings to a bronze casting to pass a 150% hydrostatic test and a dye penetrant examination.

1.3.1.1 Replaces pump wearing rings by sil-brazing monel to cast monel for acceptance in accordance with Mil-Std 278.

1.3.1.2 Replaces pump wearing rings by sil-brazing brass to cast bronze for acceptance in accordance with Mil-Std 278.

1.3.1.3 Replaces pump wearing rings by sil-brazing CRES to cast CRES for acceptance in accordance with Mil-Std 278.

1.4.1.1 Repairs strainer baskets by sil-brazing on copper nickel for acceptance in accordance with approved shipboard procedures.

1.4.1.2 Repairs strainer baskets by sil-brazing on CRES for acceptance in accordance with approved shipboard procedures.

2.0 BRAZE WELDING TASKS

2.1.1.1 Repairs pump impellers by braze welding cracks in bronze castings for acceptance in accordance with Mil-Std 278.

2.1.1.2 Repairs pump wearing rings by braze welding worn areas on bronze castings for acceptance in accordance with Mil-Std 278.

2.1.1.3 Repairs main and auxiliary machinery housings by braze welding cracks in bronze casting for acceptance in accordance with Mil-Std 278.

2.1.1.4 Repairs main and auxiliary machinery housings by braze welding cracks in iron castings for acceptance in accordance with Mil-Std 278.

2.1.1.5 Repairs main and auxiliary machinery small components by braze welding cracks in iron castings for acceptance in accordance with Mil-Std 278.

2.1.1.6 Repairs pump housings by braze welding cracks in steel castings for acceptance in accordance with Mil-Std 278.

2.2.1.1 Repairs fittings and valve bodies by braze welding cracks in bronze castings for acceptance in accordance with Mil-Std 278.

2.2.1.2 Repairs diesel exhaust manifolds by braze welding cracks in iron castings for acceptance in accordance with Mil-Std 278.

2.2.1.3 Repairs fittings and valve bodies by braze welding cracks in iron castings for acceptance in accordance with Mil-Std 278.

2.2.1.4 Repairs throttle valve seats by hard surfacing (with a braze welding technique) worn areas on steel castings for acceptance in accordance with Mil-Std 278.

2.2.2.1 Builds up valve bodies by braze welding worn areas on bronze castings for acceptance in accordance with Mil-Std 278.

2.2.2.2 Repairs valve seats by hard surfacing (with a braze welding technique) worn areas on iron castings for acceptance in accordance with Mil-Std 278.

2.3.1.1 Repairs boat propellers by braze welding cracks in bronze castings for acceptance in accordance with NavShips 0991-023-3000.

2.3.1.2 Repairs winch drums and capstans by braze welding cracks in bronze castings for acceptance in accordance with Mil-Std 278.

2.3.1.3 Repairs sheaves and blocks by braze welding cracks in iron castings for acceptance in accordance with Mil-Std 278.

2.3.1.4 Repairs pump pulleys by braze welding cracks in iron castings for acceptance in accordance with Mil-Std 278.

2.3.1.5 Repairs sheaves and blocks by braze welding cracks in steel castings for acceptance in accordance with Mil-Std 278.

2.3.1.6 Repairs stern tube packing gland ring by braze welding cracks in an aluminum bronze casting for acceptance in accordance with Mil-Std 278.

2.4.1.1 Repairs auxiliary machinery shafts by braze welding ferrous metals for acceptance in accordance with Mil-Std 278.

2.4.2.1 Builds up auxiliary machinery shafts by braze welding ferrous metals for acceptance in accordance with Mil-Std 278.

2.5.1.1 Repairs auxiliary fuel tanks (e.g., in boats) by braze welding on carbon steel for acceptance in accordance with Mil-Std 278.

2.6.1.1 Repairs diesel exhaust expansion joint by braze welding carbon steel for acceptance in accordance with Mil-Std 278.

3.0 FUEL GAS WELDING TASKS

3.1.1.1 Installs fittings on auxiliary fuel tanks (e.g., in boats) by fuel gas welding fillet welds on carbon steel for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

3.1.2.1 Repairs auxiliary fuel tanks (e.g., in boats) by fuel gas welding on ruptured seams on carbon steel for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.0 TIG WELDING TASKS

4.1.1.1 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding ruptured seams in carbon steel for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.1.1.2 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding ruptured seams in aluminum for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.1.1.3 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding ruptured seams in CRES for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.1.2.1 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding cracks in carbon steel for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.1.2.2 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding cracks in aluminum for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.1.2.3 Repairs auxiliary fuel tanks (e.g., in boats) by TIG welding cracks in CRES for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.1.3.1 Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on carbon steel for acceptance in accordance with Mil-Std 278.

4.1.3.2 Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on aluminum for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.1.3.3 Installs fittings on auxiliary fuel tanks (e.g., in boats) by TIG welding a fillet weld on CRES for acceptance in accordance with approved shipboard procedures and NavShips 0900-003-8000.

4.2.1.1 Repairs brine tanks and hagevap tanks by TIG welding ruptured seams in CRES for acceptance in accordance with Mil-Std 278.

4.2.2.1 Repairs brine tanks and hagevap tanks by TIG welding cracks in CRES for acceptance in accordance with Mil-Std 278.

4.3.1.1 Repairs pump wearing rings by TIG welding cracks on cast CRES for acceptance in accordance with Mil-Std 278.

4.3.2.1 Builds up pump wearing rings by TIG welding worn areas on cast CRES for acceptance in accordance with Mil-Std 278.

4.4.1.1 Repairs pump impellers by TIG welding cracks on aluminum for acceptance in accordance with Mil-Std 278.

4.4.2.1 Builds up pump impellers by TIG welding eroded areas on aluminum for acceptance in accordance with Mil-Std 278.

4.4.2.2 Builds up pump impellers by TIG welding eroded areas on CRES for acceptance in accordance with Mil-Std 278.

4.5.1.1 Repairs pump housings by TIG welding cracks in monel for acceptance in accordance with Mil-Std 278.

4.5.1.2 Repairs pump housings by TIG welding cracks in aluminum for acceptance in accordance with Mil-Std 278.

4.5.1.3 Repairs pump housings by TIG welding cracks in CRES for acceptance in accordance with Mil-Std 278.

4.5.2.1 Builds up pump housings by TIG welding eroded areas on monel for acceptance in accordance with Mil-Std 278.

4.5.2.2 Builds up pump housings by TIG welding eroded areas on aluminum for acceptance in accordance with Mil-Std 278.

4.5.2.3 Builds up pump housings by TIG welding eroded areas on CRES for acceptance in accordance with Mil-Std 278.

4.6.1.1 Repairs strainer baskets by TIG welding lap joints on CRES for acceptance in accordance with Mil-Std 278.

4.6.2.1 Repairs strainer baskets by TIG welding butt joints on CRES for acceptance in accordance with Mil-STD 278.

4.6.3.1 Repairs strainer baskets by TIG welding cracks on CRES material for acceptance in accordance with Mil-Std 278.

4.7.1.1 Repairs machinery guards by TIG welding tee joints on aluminum for acceptance in accordance with Mil-Std 278.

4.7.2.1 Repairs machinery guards by TIG welding butt joints on aluminum for acceptance in accordance with Mil-Std 278.

4.7.3.1 Repairs machinery guards by TIG welding cracks in aluminum for acceptance in accordance with Mil-Std 278.

4.8.1.1 Repairs throttle valve seats by hardfacing (with a TIG welding technique) on an iron casting for acceptance in accordance with Mil-Std 278.

4.8.1.2 Repairs throttle valve seats by hardfacing (with a TIG welding technique) on a steel casting for acceptance in accordance with Mil-Std 278.

4.9.1.1 Repairs valve bodies by TIG welding cracks in bronze for acceptance in accordance with Mil-Std 278.

4.10.1.1 Replace valve seats by TIG welding brass valve seats to a bronze valve body in accordance with Mil-Std 278.

5.0 MIG WELDING TASKS

5.1.1.1 Repairs decks, hulls, and superstructures by MIG welding a butt joint in aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.1.2.1 Repairs decks, hulls, and superstructures by MIG welding a lap joint on aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.2.1.1 Repairs foundations, boom cradles, fixtures and bands on masts, booms, yardarms and davits by MIG welding cracks in aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.2.1.2 Repairs foundations, boom cradles, fixtures, and bands on masts, booms, yardarms, and davits by MIG welding cracks in aluminum pipe for acceptance in accordance with NavShips 0900-000-1000.

5.3.1.1 Repairs structural piping by MIG welding a butt joint in aluminum pipe for acceptance in accordance with NavShips 0900-000-1000.

5.3.2.1 Repairs structural piping by MIG welding a socket joint in aluminum pipe for acceptance in accordance with NavShips 0900-000-1000.

5.3.3.1 Repairs structural piping by MIG welding a tee joint in aluminum pipe for acceptance in accordance with NavShips 0900-000-1000.

5.3.3.2 Repairs structural piping by MIG welding a tee joint between aluminum pipe and aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.4.1.1 Attaches fixtures to masts, booms, yardarms, and davits by MIG welding a butt joint in aluminum structural pipe for acceptance in accordance with NavShips 0900-000-1000.

5.4.1.2 Attaches fixtures to masts, booms, yardarms, davits, hulls, and superstructures by MIG welding a butt joint in aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.4.1.3 Repairs fixtures on masts, booms, yardarms, and davits by MIG welding a butt joint in aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.4.2.1 Repairs fixtures on masts, booms, yardarms, and davits by MIG welding a lap joint on aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.4.2.2 Attaches fixtures to masts, booms, yardarms, and davits by MIG welding a lap joint on aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.4.3.1 Repairs fixtures on masts, booms, yardarms, and davits by MIG welding a tee joint on aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.4.3.2 Attaches fixtures to masts, booms, yardarms, davits, hulls and superstructures by MIG welding a tee joint on aluminum plate for acceptance in accordance with NavShips 0900-000-1000.

5.5.1.1 Repairs pump housings by MIG welding cracks in cast aluminum for acceptance in accordance with Mil-Std 278.

5.6.1.1 Repairs pump impellers by MIG welding cracks in cast aluminum for acceptance in accordance with Mil-Std 278.

5.7.1.1 Repairs machinery guards by MIG welding a butt joint in aluminum shapes for acceptance in accordance with Mil-Std 278.

5.7.2.1 Repairs machinery guards by MIG welding a lap joint on aluminum shapes for acceptance in accordance with Mil-Std 278.

5.8.1.1 Repairs watertight doors and hatches by MIG welding cracks and holes in aluminum alloys for acceptance in accordance with NavShips 0900-000-1000.

6.0 MMA WELDING TASKS (PLATE)

6.1.1.1 Repairs decks, bulkheads, and overheads by MMA welding butt joints in mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.2 Repairs decks, bulkheads, and overheads by MMA welding butt joints in STS for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.3 Repairs decks, bulkheads, and overheads by transition MMA welding butt joints between STS and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.4 Repairs decks, bulkheads, and overheads by MMA welding butt joints in HTS for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.5 Repairs decks, bulkheads and overheads by transition MMA welding butt joints between HTS and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.6 Repairs decks, bulkheads, and overheads by transition MMA welding butt joints between HTS and STS for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.7 Repairs decks, bulkheads and overheads by MMA welding butt joints in HY-80 for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.8 Repairs decks, bulkheads and overheads by transition MMA welding butt joints between HY-80 and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.9 Repairs decks, bulkheads and overheads by transition MMA welding butt joints between HY-80 and STS plate for acceptance in accordance with NavShips 0900-000-1000.

6.1.1.10 Repairs decks, bulkheads and overheads by transition MMA welding butt joints between HY-80 and HTS plate for acceptance in accordance with NavShips 0900-000-1000.

6.2.1.1 Repairs hulls, superstructures, watertight doors and hatches, hatch combings and watertight door frames by MMA welding cracks in mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.2.2.1 Repairs hulls and superstructures by MMA welding a butt joint in mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.2.3.1 Repairs hulls and supersturctues by MMA welding a lap patch on mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.1.1 Repairs foundations, boom cradles, fixtures, and boom bands on masts, booms, yardarms, and davits by MMA welding cracks in mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.1.2 Repairs foundations, boom cradles, and fixtures on masts, booms, yardarms, and davits by transition MMA welding cracks between STS and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.2.1 Repairs foundations, boom cradles, fixtures, and boom bands on masts, booms, yardarms, and davits by MMA welding butt joints in mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.2.2 Repairs foundations, boom cradles and fixtures on masts, booms, yardarms and davits by transition MMA welding butt joints between STS and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.3.1 Repairs foundations, boom cradles, fixtures and boom bands on masts, booms, yardarms and davits by MMA welding lap joints on mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.3.2 Repairs foundations, boom cardles, and fixtures on masts, booms, yardarms and davits by transition MMA welding lap joints between STS and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.4.1 Repairs foundations, boom cardles, fixtures and boom bands on masts, booms, yardarms and davits by MMA welding tee joints on mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.3.4.2 Repairs foundations, boom cradles, and fixtures on masts, booms, yardarms and davits by transition welding tee joints between STS and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.4.1.1 Repairs gun shields by MMA welding a butt joint in HY-80 steel for acceptance in accordance with NavShips 0900-000-1000.

6.5.1.1 Repairs faying surfaces on hulls and gun shields by transition MMA welding a lap joint between HY-80 and mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.6.1.1 Repairs watertight door frames and hatch combings by MMA welding (build up) knife edges on CRES for acceptance in accordance with NavShips 0900-000-1000.

6.7.1.1 Repairs machinery foundations by MMA welding cracks in mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.7.2.1 Repairs machinery guards by MMA welding butt joints in mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.7.3.1 Repairs machinery guards by MMA welding lap joints on mild steel for acceptance in accordance with Mil-Std 278.

6.8.1.1 Repairs auxiliary machinery shaft by MMA welding a butt joint in mild steel for acceptance in accordance with Mil-Std 278.

6.8.1.2 Repairs auxiliary machinery shafts by MMA welding a butt joint in CRES for acceptance in accordance with Mil-Std 278.

6.8.2.1 Repairs main and auxiliary machinery by MMA welding mild steel (handwheels, levers, brackets, braces, etc.) for acceptance in accordance with Mil-Std 278.

6.9.1.1 Repairs pump housings by MMA welding cracks in cast bronze for acceptance in accordance with Mil-Std 278.

6.9.1.2 Repairs pump housings, main and auxiliary machinery housings, diesel exhaust manifolds, and bearing housings by MMA welding cracks in iron castings for acceptance in accordance with Mil-Std 278.

6.9.1.3 Repairs pump housings, main and auxiliary machinery housings and bearing housings by MMA welding cracks in steel castings for acceptance in accordance with Mil-Std 278.

6.9.1.4 Repairs pump housings by MMA welding cracks in cast CRES for acceptance in accordance with Mil-Std 278.

6.9.2.1 Builds up pump housings by MMA welding worn areas on bronze castings for acceptance in accordance with Mil-Std 278.

6.9.2.2 Builds up pump housings, diesel exhaust manifolds, and bearing housings by MMA welding worn areas on iron castings for acceptance in accordance with Mil-Std 278.

6.9.2.3 Builds up pump housings and bearing housings by MMA welding worn areas in steel castings for acceptance in accordance with Mil-Std 278.

6.9.2.4 Builds up pump housings by MMA welding worn areas in cast CRES for acceptance in accordance with Mil-Std 278.

6.10.1.1 Repairs pump impellers by MMA welding cracks in bronze castings for acceptance in accordance with Mil-Std 278.

6.10.1.2 Repairs pump impellers by MMA welding cracks in monel castings for acceptance in accordance with Mil-Std 278.

6.10.1.3 Repairs pump pulleys and pump impellers by MMA welding cracks in steel castings for acceptance in accordance with Mil-Std 278.

6.10.1.4 Repairs pump impellers by MMA welding cracks in CRES castings for acceptance in accordance with Mil-Std 278.

6.10.2.1 Replaces centrifugal pump wearing rings by MMA welding butt joints in steel castings for acceptance in accordance with Mil-Std 278.

6.10.3.1 Builds up centrifugal pump wearing rings by MMA welding worn areas on monel castings for acceptance in accordance with Mil-Std 278.

6.10.3.2 Builds up centrifugal pump wearing rings by MMA welding worn areas on monel castings for acceptance in accordance with Mil-Std 278.

6.11.1.1 Repairs strainer baskets by MMA welding butt joints in copper nickel for acceptance in accordance with Mil-Std 278.

6.11.1.2 Repairs strainer baskets by MMA welding butt joints in monel for acceptance in accordance with Mil-Std 278.

6.11.1.3 Repairs strainer baskets by MMA welding butt joints in CRES for acceptance in accordance with Mil-Std 278.

6.11.2.1 Repairs strainer baskets by MMA welding lap joints on copper nickel for acceptance in accordance with Mil-Std 278.

6.11.2.2 Repairs strainer baskets by MMA welding lap joints on monel for acceptance in accordance with Mil-Std 278.

6.11.2.3 Repairs strainer baskets by MMA welding lap joints on CRES for acceptance in accordance with Mil-Std 278.

6.12.1.1 Repairs brine tanks, hagevap tanks and condensor headers by MMA welding cracks in copper nickel for acceptance in accordance with Mil-Std 278.

6.12.1.2 Repairs brine tanks and hagevap tanks by MMA welding cracks in CRES for acceptance in accordance with Mil-Std 278.

6.12.2.1 Repairs brine tanks and hagevap tanks by MMA welding butt joints in copper nickel for acceptance in accordance with Mil-Std 278.

6.12.2.2 Repairs brine tanks and hagevap tanks by MMA welding butt joints in CRES for acceptance in accordance with Mil-Std 278.

6.13.1.1 Repairs sheaves and blocks by MMA welding cracks on iron castings for acceptance in accordance with Mil-Std 278.

6.13.1.2 Repairs sheaves, blocks, winch drums and capstan drums by MMA welding cracks in steel castings for acceptance in accordance with Mil-Std 278.

6.14.1.1 Repairs stern tube packing gland ring by MMA welding cracks in aluminum bronze casting for acceptance in accordance with Mil-Std 278.

6.15.1.1 Repairs tube guard on a solo-shell evaporator by MMA welding cracks in monel for acceptance in accordance with Mil-Std 278.

6.16.1.1 Repairs winch and capstan brake bands and winch dogs (pawls) by MMA welding cracks in mild steel for acceptance in accordance with Mil-Std 278.

6.16.2.1 Builds up winch dogs (pawls) by MMA welding worn areas on mild steel for acceptance in accordance with Mil-Std 278.

6.17.1.1 Repairs rudders (e.g., in boats) by MMA welding cracks in mild steel for acceptance in accordance with Mil-Std 278.

6.17.2.1 Repairs rudders (e.g., in boats) by MMA welding butt joints in mild steel for acceptance in accordance with Mil-Std 278.

6.18.1.1 Repairs auxiliary fuel tanks (e.g., in boats) by MMA welding ruptured seams on mild steel for acceptance in accordance with Mil-Std 278.

6.18.2.1 Repairs auxiliary fuel tanks (e.g., in boats) by MMA welding cracks in mild steel for acceptance in accordance with Mil-Std 278.

6.18.3.1 Installs fittings on auxiliary fuel tanks (e.g., in boats) by MMA welding fillet welds on mild steel for acceptance in accordance with Mil-Std 278.

6.19.1.1 Installs fixtures on hulls and superstructures by MMA welding fillet welds on mild steel for acceptance in accordance with NavShips 0900-000-1000.

6.19.1.2 Installs fixtures on hulls and superstructures by MMA welding fillet welds on HY-80 for acceptance in accordance with NavShips 0900-000-1000.

6.20.1.1 Repairs fixtures on masts, booms, yardarms and davits by MMA welding cracks in mild steel pipe for acceptance in accordance with NavShips 0900-000-1000.

6.20.2.1 Attaches fixtures to masts, booms, yardarms and davits by MMA welding a tee joint on mild steel pipe for acceptance in accordance with NavShips 0900-000-1000.

6.21.1.1 Repairs shafts by MMA welding a butt joint in a mild steel round stock for acceptance in accordance with Mil-Std 278.

6.21.2.1 Builds up shafts by MMA welding eroded areas on mild steel shafts for acceptance in accordance with Mil-Std 278.

6.22.1.1 Repairs diesel exhaust flame arrestors, diesel exhaust mufflers, and exhaust expansion joint by MMA welding cracks and holes in carbon steel pipe for acceptance in accordance with Mil-Std 278.

6.22.2.1 Installs diesel exhaust mufflers by MMA welding a butt joint in carbon steel pipe for acceptance in accordance with Mil-Std 278.

6.23.1.1 Repairs structural piping by MMA welding a butt joint in carbon steel pipe for acceptance in accordance with NavShips 0900-000-1000.

6.23.2.1 Repairs structural piping by MMA welding a tee joint on carbon steel pipe for acceptance in accordance with NavShips 0900-000-1000.

6.23.2.2 Repairs structural piping by transition MMA welding a tee joint on carbon steel pipe to HTS plate for acceptance in accordance with NavShips 0900-000-1000.

6.23.2.3 Repairs structural piping by transition MMA welding a tee joint on carbon steel pipe to HY-80 plate for acceptance in accordance with NavShips 0900-000-1000.

6.23.2.4 Repairs structural piping by transition MMA welding a tee joint on carbon steel pipe to STS plate for acceptance in accordance with NavShips 0900-000-1000.

6.24.1.1 Repairs structural "T" stock by MMA welding a tee joint between mild steel "T" stock and 3/8" HY-80 plate for acceptance in accordance with NavShips 0900-000-1000.

7.0 MMA WELDING TASKS FOR CARBON STEEL AND COPPER NICKEL PIPE

7.1.1.1 Repairs Class P-1 High-pressure Air (3000 psi), JP-5, Main Steam (600 psi), and High-pressure Steam Drain systems by MMA welding a socket joint between carbon steel pipe and a ferrous casting for acceptance in accordance with Mil-Std 278.

7.1.2.1 Repairs Class P-1 High-pressure Air (3000 psi), JP-5, Main Steam 9600 psi), and High-pressure Drainage systems by MMA welding a butt joint in carbon steel pipe for acceptance in accordance with Mil-Std 278.

7.1.2.2 Repairs Class P-1 High-pressure Air (3000 psi), JP-5, Main Steam (600 psi), and High-pressure Drainage systems by MMA welding a butt joint between carbon steel pipe and a ferrous casting for acceptance in accordance with Mil-Std 278.

7.2.1.1 Repairs Class P-2 Secondary Steam, 150 psi Steam, 50 psi Steam, Low-pressure Steam Drainage (FW), Auxiliary Exhaust, Diesel Exhaust, Diesel Fuel, Fuel, Forced Draft Blower Air Piping, Ship's Service Air, and Main, Secondary, and Gravity Drainage systems by MMA welding a butt joint in carbon steel pipe for acceptance in accordance with Mil-Std 278.

7.2.1.2 Repairs Class P-2 Secondary Steam, 150 psi Steam, 50 psi Steam, Low-pressure Steam Drainage (FW), Auxiliary Exhaust, Diesel Exhaust, Diesel Fuel, Fuel, Forced Draft Blower Air Piping, Ship's Service Air, and Main, Secondary, and Gravity Drainage systems by MMA welding a butt joint between carbon steel pipe and a ferrous casting for acceptance in accordance with Mil-Std 278.

7.2.1.3 Repairs Class P-2 Firemain and Salt Water Cooling Systems by MMA welding a butt joint in copper nickel pipe for acceptance in accordance with Mil-Std 278.

7.2.2.1 Repairs Class P-2 Atmospheric Exhaust, Fixed CO_2, Fixed Foam, Lube Oil, 50 psi Steam, Auxiliary Exhaust, Diesel Exhaust, Low-pressure Steam Drainage (FW), Diesel Fuel, Forced Draft Blower Air Piping, Ship's Service Air, Secondary Steam, Fuel, and Main, Secondary, and Gravity Drainage systems by MMA welding a socket joint between carbon steel pipe and a ferrous casting for acceptance in accordance with Mil-Std 278.

7.2.2.2 Repairs Class P-2 Firemain and Salt Water Cooling systems by MMA welding a socket joint between copper nickel pipe and a copper nickel casting for acceptance in accordance with Mil-Std 278.

8.0 MMA WELDING TASKS (CARBON MOLYBDENUM AND CHROMIUM MOLYBDENUM)

8.1.1.1 Repairs class P-1 main steam (600 psi) and boiler piping by MMA welding a socket joint between CMo pipe and a carbon steel fitting for acceptance in accordance with Mil-Std 278.

8.1.1.2 Repairs class P-1 main steam (600 psi) and boiler piping by MMA welding a socket joint between CMo pipe and a carbon steel flange for acceptance in accordance with Mil-Std 278.

8.1.1.3 Repairs class P-1 main steam (1200 psi) and boiler piping by MMA welding a socket joint between CrMo pipe and a CrMo fitting for acceptance in accordance with Mil-Std 278.

8.1.1.4 Repairs class P-1 main steam (1200 psi) and boiler piping by MMA welding a socket joint between CrMo pipe and a CrMo flange for acceptance in accordance with Mil-Std 278.

8.1.2.1 Repairs class P-1 main steam (600 psi) and boiler piping by MMA welding a butt joint in CMo pipe for acceptance in accordance with Mil-Std 278.

8.1.2.2 Repairs class P-1 main steam (1200 psi) and boiler piping by MMA welding a butt joint in CrMo pipe for acceptance in accordance with Mil-Std 278.

8.1.3.1 Repairs class P-1 main steam (600 psi) and boiler piping by TIG welding a consumable insert and MMA welding a butt joint in CMo pipe for acceptance in accordance with Mil-Std 278.

8.1.3.2 Repairs class P-1 main steam (1200 psi) and boiler piping by TIG welding a consumable insert and MMA welding a butt joint in CrMo pipe for acceptance in accordance with Mil-Std 278.

9.0 MMA WELDING TASKS (HTS AND HY-80)

9.1.1.1 Repairs submarine pressure hulls by MMA welding butt joints in HY-80 for acceptance in accordance with NavShips 0900-006-9010.

9.1.1.2 Repairs submarine pressure hulls by MMA welding butt joints in HY-80 for acceptance in accordance with NavShips 0900-006-9010.

10.0 MMA AND TIG WELDING TASKS (NUCLEAR POWER PLANT COMPONENTS)

10.1.1.1 Repairs appropriate Reactor Plant systems by MMA welding a butt joint with a backing ring in 304 stainless steel pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.1.2 Repairs appropriate Reactor Plant systems by MMA welding a butt joint with a backing ring in carbon steel pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.1.3 Repairs appropriate Reactor Plant systems by MMA welding a butt joint with a backing ring in inconel 604 pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.1.4 Repairs appropriate Reactor Plant systems by MMA welding a butt joint with a backing ring in monel pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.1.5 Repairs appropriate Reactor Plant systems by MMA welding a butt joint with a backing ring in copper nickel pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.2.1 Repairs appropriate Reactor Plant systems by MMA welding a socket joint in 304 stainless steel pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.2.2 Repairs appropriate Reactor Plant systems by MMA welding a socket joint in carbon steel pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.2.3 Repairs appropriate Reactor Plant systems by MMA welding a socket joint in inconel 604 pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.2.4 Repairs appropriate Reactor Plant systems by MMA welding a socket joint in monel pipe for acceptance in accordance with NavShips 250-1500-1.

10.1.2.5 Repairs appropriate Reactor Plant systems by MMA welding a socket joint in copper nickel pipe for acceptance in accordance with NavShips 250-1500-1.

10.2.1.1 Repairs appropriate Reactor Plant systems by TIG welding a seal weld in 304 stainless steel in accordance with NavShips 250-1500-1.

10.2.1.2 Repairs Reactor Plant systems by TIG welding a seal weld in carbon steel in accordance with NavShips 250-1500-1.

10.2.1.3 Repairs appropriate Reactor Plant systems by TIG welding a seal weld in inconel 604 in accordance with NavShips 250-1500-1.

10.2.1.4 Repairs appropriate Reactor Plant systems by TIG welding a seal weld in monel in accordance with NavShips 250-1500-1.

10.2.2.1 Repairs appropriate Reactor Plant systems by TIG welding a plug in a 347 stainless steel tube sheet in accordance with NavShips 250-1500-1.

10.2.2.2 Repairs appropriate Reactor Plant systems by TIG welding a plug in carbon steel tube sheet in accordance with NavShips 250-1500-1.

10.2.2.3 Repairs appropriate Reactor Plant systems by TIG welding a plug in an inconel 604 sheet in accordance with NavShips 250-1500-1.

10.2.2.4 Repairs appropriate Reactor Plant systems by TIG welding a plug in a monel tube sheet in accordance with NavShips 250-1500-1.

10.3.1.1 Repairs appropriate Reactor Plant systems by TIG welding a consumable insert and MMA welding a butt joint in 304 stainless steel pipe for acceptance in accordance with NavShips 250-1500-1.

10.3.1.2 Repairs appropriate Reactor Plant systems by TIG welding a consumable insert and MMA welding a butt joint in carbon steel pipe for acceptance in accordance with NavShips 250-1500-1.

10.3.1.3 Repairs appropriate Reactor Plant systems by TIG welding a consumable insert and MMA welding a butt joint in inconel 604 pipe for acceptance in accordance with NavShips 250-1500-1.

10.3.1.4 Repairs appropriate Reactor Plant systems by TIG welding a consumable insert and MMA welding a butt joint in monel pipe for acceptance in accordance with NavShips 250-1500-1.

10.3.1.5 Repairs appropriate Reactor Plant systems by TIG welding a consumable insert and MMA welding a butt joint in copper nickel pipe for acceptance in accordance with NavShips 250-1500-1

10.3.2.1 Repairs appropriate Reactor Plant systems by TIG welding the first layer and MMA welding the remaining layers of a seal weld in 304 stainless steel in accordance with NavShips 250-1500-1.

10.3.2.2 Repairs appropriate Reactor Plant systems by TIG welding the first layer and MMA welding the remaining layers of a seal weld in carbon steel in accordance with NavShips 250-1500-1.

10.3.2.3 Repairs appropriate Reactor Plant systems by TIG welding the first layer and MMA welding the remaining layers of a seal weld in inconel 604 in accordance with NavShips 250-1500-1.

10.3.2.4 Repairs appropriate Reactor Plant systems by TIG welding the first layer and MMA welding the remaining layers of a seal weld in monel in accordance with NavShips 250-1500-1.

10.4.1.1 Repairs appropriate Reactor Plant systems by transition MMA welding carbon steel to monel using a socket joint for acceptance in accordance with NavShips 250-1500-1.

10.4.1.2 Repairs appropriate Reactor Plant systems by transition MMA welding carbon steel to 304 stainless steel using a socket joint for acceptance in accordance with NavShips 250-1500-1.

10.4.1.3 Repairs appropriate Reactor Plant systems by transition MMA welding monel to 304 stainless steel using a socket joint for acceptance in accordance with NavShips 250-1500-1.

10.4.1.4 Repairs appropriate Reactor Plant systems by transition MMA welding monel to inconel 604 using a socket joint for acceptance in accordance with NavShips 250-1500-1.

10.4.1.5 Repairs appropriate Reactor Plant systems by transition MMA welding 304 stainless steel to inconel 604 using a socket joint for acceptance in accordance with NavShips 250-1500-1.

APPENDIX H

LESSON PLAN GUIDANCE

FOR TRAINING
INVENTORY TASK:

Supplemental Information

2. TIG inert gas and equipment characteristics and procedures to set up and energize:

a. Fuel and equipment:

(1) Argon: gaseous element; colorless; odorless; non-flammable; inert; and helium or a mixture of argon and helium may be used.

(2) Argon cylinder: Shatterproof (NON SHAT); Navy bottles - gray with white bands (one band - water pumped and two bands - oil pumped); commercial bottles - brown; 200 cubic foot capacity normally used; and 1800 psi full pressure.

(3) Regulators: Usually combination two-stage regulator and flow meter; older models restricted to a specific gas and not interchangeable because helium flow meters plug up when connected to argon; newer models handle both argon and helium and with slight modification handle CO_2; gas pressure preset by manufacturer and varies with regulator model number and style with output pressure usually about 20 psi; and argon flow adjustable, usually up to 60 cfh.

(4) Hoses: Compressed air or standard oxygen hoses and fittings.

(5) Power source (AC-DC Welding Machine): High frequency rectifier recommended; machines available in various amperage ratings with 300 amperage equipment usually adequate for most jobs; and high frequency machines required.

(6) Tungsten: Pure for aluminum; 2% thorium for all other materials; and 3% - 5% Zirconium used for extremely high quality work using AC current.

(7) Torches (air-cooled): 110 maximum amperage; various size ceramic cups; collets available in various sizes depending upon size of tungsten used; chuck holds collet; shielding gas flows around power cable for cooling, and torch body made out of bakelite and contains two "O" rings.

(8) Torches (water-cooled): 800 maximum amperage; various size ceramic cups; collets available in various sizes depending on size of tungsten used; chuck holds collet; cooling water flows around power cable; torch body made out of bakelite and contains two "O" rings; and cooling water requirements vary depending upon the torch design for different amperage ranges.

b. Procedure to set up TIG equipment:

(1) Connect regulator-flow meter to inert gas supply.

(2) Connect inert gas hose from regulator to welding machine or torch as required.

(3) Set welding machine for straight polarity.

(4) Connect ground lead from positive terminal of welding machine to the work.

(5) Connect torch power cable to the negative terminal of the welding machine.

(6) Set welding machine to recommended amperage.

(7) Grind tungsten to a point.

(8) Insert tungsten into TIG torch leaving a maximum of 3/16" extending beyond the end of the ceramic cup.

c. Procedure to energize TIG equipment:

(1) Open inert gas supply valve.

(2) Adjust inert gas flow to desired cfh.

(3) Set machine to proper current, e.g., AC or DC/SP.

(4) Set high frequency control as required.

(5) Adjust amperage to recommended setting.

(6) Ensure tungsten electrode is clear of ground.

(7) Energize welding machine.

3. Maintenance procedures:

a. Routine maintenance:

(1) Keep unit clean and dust free.

(2) Blow with low pressure clean dry air monthly.

(3) Replace ceramic cap when necessary.

(4) Replace "O" rings.

(5) Replace collets and chuck when necessary.

(6) Replace power cable when broken.

b. Troubleshooting - No arc:

(1) Check on/off switch on welding machine.

(2) Check on/off switch on power source.

(3) Check ground cable.

(4) Check power cable.

(5) Check polarity switch.

(6) Call electrician if still no arc.

c. Troubleshooting - No inert gas flow:

(1) Check gas supply.

(2) Check flow meter.

(3) Check hose for crimping.

(4) Check gas orifices for obstruction.

4. Protective equipment and characteristics:

   a. Helmet: protects face from heat, ultraviolet, and infrared rays.

   b. Protective lens: protects filter lens and eyes from foreign objects.

   c. Filter lens: lens number is individual's choice; and protects eyes from infrared and ultraviolet rays.

   d. Gloves: Protects hands from electrical shock and burns.

   e. Welding cap: Protects hair.

   f. Welding leathers: Protects body from burns.

5. TIG reference manuals:

   a. Naval Ships Technical Manual, Chapter 9920, Welding and Allied Processes.

   b. Mil-Std-00248B (SHIPS), Welding and Brazing Procedure and Performance Qualification.

6. TIG base metals and filler materials:

   a. TIG base metals and identification:

   (1)

Base Metals	Identification
Aluminum	Acid
CRES	Acid
Monel	Acid
Brass	Acid
Bronze	Acid
Carbon Steel	Magnet and acid

   b. TIG filler materials and identification

   (1)

Filler Materials	Identification
Aluminum	Manufacturer's shipping tag (bulk)
Carbon Steel	Manufacturer's shipping tag (bulk)
Monel	Manufacturer's shipping tag (bulk)
CRES	Individually tagged or stamped rods
Brass	Manufacturer's shipping tag (bulk)

7. Procedures to assemble L-1 lap, T-1 toe, and B-5 butt joints:

a. L-1 lap joint:

(1) Clean surfaces to be welded ½" from the expected toe of the weld.

(2) Overlap plates 5 X T of the thinnest member.

(3) Clamp plates together.

(4) Check alignment.

(5) Tack weld.

b. T-1 tee joint:

(1) Clean surfaces to be welded ½" from the expected toe of the weld.

(2) Place plates together (butt at 90°).

(3) Tack weld.

(4) Check alignment.

8. Materials and cleaning methods to remove extraneous materials from TIG welding surfaces:

a. Materials: File; acetone or alcohol; abrasive cloth; hand or rotary stainless steel wire brush; metallic stainless steel wool; industrial clean wiping cloth; and water.

b. Cleaning methods:

(1) Clean edges of base materials for a distance of ½" from the expected toe of the weld using any one or a combination of the following methods:

(a) Rub with abrasive cloth followed by wiping with acetone, alcohol, or water damp clean cloth.

(b) Rub with stainless steel wool followed by wiping with acetone, or water damp clean cloth.

(c) Brush with stainless steel wire brush (hand or rotary) followed by wiping with acetone, alcohol, or water damp clean cloth.

(2) Do not handle the cleaned surfaces.

(3) Reclean all parts which have not been welded within eight hours.

9. Tack welding procedure:

a. Limit tack welds to approximately $\frac{1}{4}$" in length.

b. Make tacks so that they may be easily included in the final weld.

c. Make tack welds every 6" for long sections.

d. Remove and reweld all cracked or poorly made welds.

e. Do not weld beads.

f. Tack weld each end for lap, tee, and butt joints.

g. Slot and hole as necessary.

10. Fusion welding procedure:

a. Strike arc.

(1) Make contact, without high frequency, between base material and tungsten electrode.

(2) Establish arc with high frequency by holding tungsten electrode approximately $\frac{1}{4}$" from base material (precise distance depends on intensity of high frequency adjustment).

b. Establish puddle at one end of joint.

c. Commence travel (insuring fusion of both plates).

(1) Control speed by puddle size.

(2) Keep puddle size uniform at all times.

d. Complete weld.

e. Stop forward travel.

f. Lift torch slowly until arc is broken.

11. Procedure to TIG weld a pass (process basically identical for all joints):

a. Strike arc:

(1) Make contact, without high frequency, between base materials and tungsten electrode.

(2) Establish arc with high frequency by holding tungsten electrode approximately $\frac{1}{2}$" from base material (precise distance depends on intensity of high frequency adjustment).

b. Establish puddle at one end of joint.

c. Apply filler material at leading edge of puddle.

d. Commence travel, insuring fusion of both plates, with travel always toward filler material.

e. Continue travel, adding filler material as required, to produce a uniform weld bead.

f. Complete pass.

g. Withdraw filler material.

h. Stop forward travel.

i. Lift torch slowly until arc is broken; avoid melting ends of plates while breaking arc.

j. Repeat process as necessary to complete a multi-layer weld; however, clean each successive pass.

12. Types of visible defects in TIG welded joints, causes of, and repairs required:

a. Visible defects and causes of:

Defects	Causes
Undercut	Lack of filler material.
Cracks	Improper cooling.
Fuse through	Excessive amperage.
Burn through	Excessive amperage; absence of filler material
Incomplete fusion	Insufficient amperage; improper rod angle.
Loss of purge	Insufficient supply of inerting medium.

Porosity	Long arcing.
Improper fit-up	Not following procedure.
Excessive reinforcement	Too much filler material; insufficient rate of travel.
Insufficient reinforcement	Excessive rate of travel; insufficient filler material.
Cold spot	Incomplete melting of filler material.
Tungsten inclusion	Sticking tungsten electrode.

b. Visible defects and repairs of:

Defects	Repair
Undercut	Add more filler material.
Cracks	Remove and reweld.
Fuse through	Do not repair.
Burn through	Do not repair.
Incomplete fusion	Increase amperage and reweld.
Loss of purge	Do not repair.
Porosity	Remove and reweld.
Improper fit-up	Do not repair.
Excessive reinforcement	Remove excess.
Insufficient reinforcement	Add more filler material.
Cold spot	Remove and reweld.
Tungsten inclusion	Remove and reweld..